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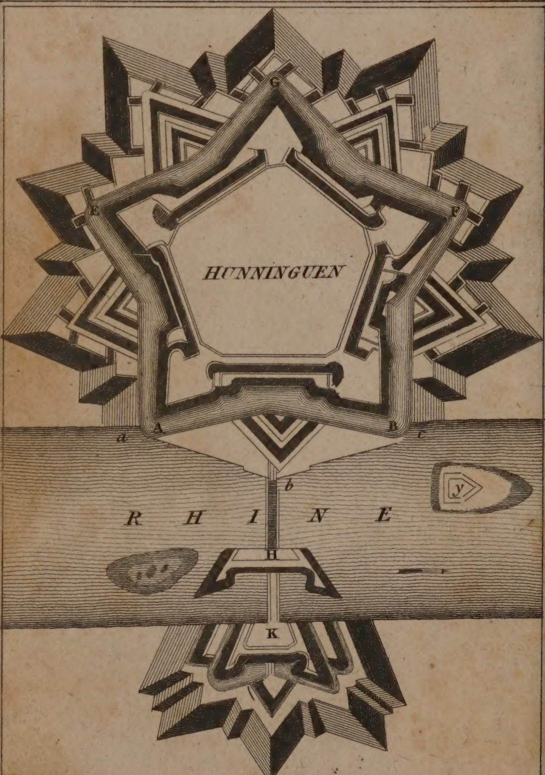

Engraved for Pinnock & Maunders Elements of Science & Art by Sid^y Hall.

THE ELEMENTS OF SCIENCE AND ART,

ILLUSTRATED

BY

ONE HUNDRED AND FIFTY ENGRAVINGS

ON

COPPER AND WOOD,

FOR

THE USE OF SCHOOLS AND PRIVATE INSTRUCTION.

BY

THE REV. JOHN BARCLAY.

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PREFACE.

In presenting this little volume to Parents and Teachers, the publishers feel that they discharge another of those duties which they owe to society. But this feeling is the more agreeable from the conviction that these Elements of Science and Art are calculated to improve both the understanding and the heart. For the various phenomena of nature which the author has illustrated on scientific principles; and the numerous productions of genius, in the useful and necessary arts of life, which he has explained in language adapted to the capacity of young people,—cannot fail to enlighten and instruct their mind; while the maxims of morality, and the duties of the Christian Religion, which he has laid down and inculcated, will doubtless form the heart for the love of truth and the practice of virtue. And if he might speak in the language of metaphor, the author conceives that youth, equipped with the armour of useful knowledge and the precepts of the gospel of our Lord and Saviour, will be enabled to enter upon the voyage of life, so as to become blessings to their families, and examples to such as have not derived the same advantages.

It seems, therefore, superfluous to say more on this point; yet a few words on the method of studying the volume, may not be altogether unacceptable to those who shall teach from this book.

The sub-divisions of the several chapters which comprise the *Elements of Science and Art* are so distinctly marked by scientific and logical arrangements, as to present all the instruction they develope, in short and easy lessons, on each of which a series of questions has been framed for the purpose of grounding the student in what he is learning.

By this means the volume is adapted to classes in schools, or to private instruction in the drawing room-

For, when a section, or lesson, has been studied and read, the questions upon that section which the tutor is supposed to ask, will necessarily impress it doubly on the pupil's mind, because the understanding is exercised in framing a reply, and the memory is improved in examining, while this intellectual process is going on, whether the answer correspond with the fact or observation that gave rise to the question. And here there can never be any mistake, since the numerical references to the questions lead directly to the facts or observations on which they were framed; and these facts and observations are the proper answers to their respective questions.

In embellishing the pages of the volume with so many engravings and cuts, the publishers flatter themselves that they have consulted the instruction of the rising generation with a degree of liberality rarely met with in school books; but in this they were guided by the experience of what was best calculated to do most good in the least time.

Yet after all, since there is no perfection on earth, if teachers or parents will point out wherein the author has failed or erred in the plan or matter of this volume, he will thankfully avail himself of such communication, addressed to him at the publishers, and take care that, in the next edition, those observations are attended to so far as they coincide with his own views and his publishers' interests.

Nor can the author conclude this brief preface, without noticing to Parents and Teachers that the work before them is only one of a series which Messrs. Pinnock and Maunder have published as sequels to their very useful catechisms. The other works are "THE ELEMENTS OF NATURAL AND EXPERIMENTAL PHILOSOPHY," and "THE ELEMENTS of POLITE LITERATURE," forming together a complete Juvenile Encyclopædia of useful knowledge, adapted to both sexes in those ranks of life distinguished for knowledge and virtue.

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THE ELEMENTS

OF

SCIENCE AND ART.

CHAPTER I.

OF SCIENCE AND ART IN GENERAL.

1. SCIENCE is the knowledge of *general rules* and their applications.

2. A GENERAL RULE is the expression of what is common, or of what is required to be common in a number of particular cases. And general rules are the result of *observation*, or *will;* and must, consequently, be derived from MIND.

3. A *science*, then, is a system of general truths relative to some branch of HUMAN KNOWLEDGE, and it is supported by EVIDENCE, either *demonstrative* or *probable.*

4. HUMAN KNOWLEDGE divides itself into three great branches, adapted to the MEMORY, the UNDERSTANDING and the IMAGINATION.

5. To the MEMORY may be addressed *History*, which, in its most extensive sense, includes all

facts relative to *nature*, or *society*, of which we can obtain intelligence, and which we can commit to record.

6. To the UNDERSTANDING is addressed PHILOSOPHY, which, in its enlarged meaning, contains under it all information relative to *sciences* or *arts*, attainable by the exercise of the *understanding*, or by *experience* and *practice*.

7. To the IMAGINATION is addressed POETRY, which, in its expanded range, implies all those branches of knowledge that contribute chiefly to engage or interest the affections or the heart. In this sense the term poetry is not restricted to metrical composition, but extends to all elegant productions of art, whether communicated by *language*, by the *chisel*, the *pencil*, or the *graving tool*.

8. ART is the application of knowledge to *practice*.

9. An *Art*, therefore, implies the application of the *organs* of the body, or the *faculties* of the mind, to the execution of some design, directed by the best principles and rules of practice.

10. PRACTICE, or conduct of any sort, though regulated by general rules, has a continual reference to particulars. In *speculation* we endeavour to establish general rules; in *practice*, we study particular cases, or apply general rules to regulate our conduct.

11. The ORGANS of the body are the SENSES, *seeing*, *hearing*, *smelling*, *tasting* and *feeling*, those of speech, those of the nerves, &c. to which we add the *limbs*.

12. The FACULTIES of the mind are *consciousness, sensation, perception, conception, abstraction, memory, imagination, association, reason, judgment* and *moral perception.*

13. A DESIGN is something that implies the exercise of some or all the intellectual faculties; but chiefly *perception, imagination, reason* and *judgment.*

14. PRINCIPLES are *general rules* applied to explain or regulate *particulars;* and EXPLANATIONS or *injunctions* from principle, are termed *theory* or *sÿstem.*

15. The PARTICULARS to be explained are termed *phenomena.*

Observation. We sometimes find the *same* branch of science denominated, promiscuously, a science, and an art. Now all the *principles* of science have some reference to practice; and the *theory* of every art may merit the appellation of a science. And besides the distinctions which we have pointed out above, between a science and an art, we may further characterize them thus:

16. A SCIENCE is addressed entirely to the *understanding;* an ART generally occupies both the *understanding* and the *members* of the body. A SCIENCE is acquired by *study* alone; an ART cannot be acquired without much *practice* of the operations which it contains.

17. *Accurate knowledge* is all that is necessary in *science; eminence* in *art* demands besides, an acquaintance with rules and the habit of dextrous and ready performance.

Observation. (1.) ARTS are commonly divided into *useful* and *mechanic, liberal* or *polite;* the former are those wherein the hand and body are more concerned than the mind; of which kind are most of those that furnish us with the *necessaries* of life, and are properly known by the name of trades; as, baking, brewing, weaving, carpentry, &c. The latter are such as depend more upon the labour of the mind, than that of the hand; they are the produce of the *imagination*, their essence consists in *expression*, and their end is *pleasure*. Of this kind are eloquence, poetry, music, painting, sculpture, graving, architecture, &c.

(2.) Among the sciences have been reckoned theology, philosophy, jurisprudence, rhetoric, grammar, the mathematics, &c.

18. Every *inquiry* proceeds upon a supposition that some measure of knowledge is attainable in the subject to which the inquiry refers. If we despair of knowledge, we shall cease to inquire.

19. The *evidence* of reality is various and unequal in different instances; but all EVIDENCE may be referred to from titles, *consciousness, perception, testimony*, and *inference*.

Illustration. (1.) The *evidence of consciousness* rests upon intuitive truths; as that " the whole is greater than any of its parts."

(2.) The *evidence of perception* rests upon the external senses, as *seeing, hearing, feeling*, &c.

(3.) The *evidence of testimony* is called probable evidence, and depends not upon an argument or one fact, but upon many arguments or many facts uniting their force to lead to the same conclusion.

(4.) *Inferential evidence* may be drawn from demonstration or probable evidence, and is hence called sometimes *analogy*.

Example. Thus, where things compared have a great similitude in their nature, and when there is reason to

think they are subject to the same laws, there may be considerable degrees of probability in inferences drawn from the analogy or similitude.

20. But, in general, all EVIDENCE is either *demonstrative* or *probable*.

Illustration. (1.) *Demonstrative evidence* is founded on axioms or truths evident at first sight. All mathematical reasoning is founded on this evidence.

(2.) *Probable evidence* rests upon contingent truths; so that what is *probable* is not certain; whereas demonstrative evidence being grounded upon what is known to us intuitively, admits of no contingency or doubt, but is irresistible at first sight.

Questions for Examination.

1. What is science?
2. What is a general rule? and of what are general rules the result?
3. What is a science?
4. Into what is human knowledge divided?
5, 6, 7. What branch of it is addressed to the memory, the understanding and the imagination respectively?
8, 9. What is art, and an art?
10. What is practice?
11, 12. What are the organs of the body and the faculties of the mind?
13. What is a design?
14, 15. What are principles, and what particulars?
16, 17. To what is a science addressed, and to what an art?
18. Upon what does every inquiry proceed?
19. To what four titles may all evidence be referred?
Illustration. (1.) What is the evidence of consciousness?
(2.) What that of perception?
(3.) Also that of testimony?
(4.) And that too of inference?
20. What is demonstrative and what probable evidence?

CHAPTER II.

Of Hunting, Pasturage, and Agriculture.

1. *Introduction.* The first arts of mankind are to be found in the history of our island anciently ; and from the voyages and travels of modern navigators and tourists, we learn the condition of savages in our own times. For everywhere man, in an uncivilized state, appears the same : naked and without defence, his invention, his powers of reasoning, association, and judgment are exercised in procuring the first necessaries of life, or in defending himself from the inclemency of the weather.

2. The first arts are those of ***hunting, pasturage, agriculture, &c.***

I. Of Hunting.

3. Four footed beasts are hunted in the fields, woods and thickets ; and in these both with guns and greyhounds. Birds, on the contrary, are either shot in the air, or taken with nets and other devices, which exercise is called *fowling*, or they are pursued and taken by birds of prey, which exercise is called *hawking*.

In an uncivilized state men hunt to procure food and necessaries, and from the words of God to Adam, Gen. i. 26, and 28, and to Noah, Gen. ix. 2, 3. hunting was considered as a right devolved or made over to man. And the Roman jurisprudence, which was formed on the manners of the first ages, made a law of it, and established it as a maxim, that as the natural right of things which have no master belongs to the first

possessor, wild beasts, birds and fishes, are the property of whomsoever can take them first.

But the northern nations of barbarians who overran the Roman empire, bringing with them a stronger taste for the diversion, and the people being now possessed of other and more easy means of subsistence, from the lands and possessions of those they had vanquished; their chiefs and leaders began to appropriate the right of hunting, and, instead of a natural right, to make it a royal one. Thus it continues to this day; the right of hunting among us, belonging only to the king, and those who derive it from him.

4. Mankind, in their first exercises of hunting, when the cravings of nature impelled them to the chase, used darts, spears, bows and arrows, slings, to which succeeded nets, and engines of the simplest kind, pits, and lastly, dogs.

Hunting among the first people of every country, must also be considered the apprenticeship of the warrior. In the chace, the youth acquired courage, strength, swiftness, and dexterity in handling their arms, qualities which made them formidable to their enemies in time of war. The same weapons used in the chace, were employed in battle. Besides subsisting chiefly by the prey taken in the chace, men, in those rude times, covered themselves with the skins of their game. In time, however, these skins became articles of commerce. *See on this subject* "Pinnock and Maunder's *Elements of Natural and Experimental Philosophy.*"

Questions for Examination.

1. What is the condition of man naturally?
2. What are the first arts of mankind?
3. How are both beasts and birds hunted? How do you illustrate the natural right of all men to the chase? and how came this right to belong only to kings?

4. What implements or missiles do men at first use in hunting? and how is hunting the apprenticeship of the warrior?

II. Of Pasturage and Agriculture.

1. Pasturage is the feeding and rearing of herds of cattle; and of this first step of man towards civilization, we have the best descriptions in the Holy Scriptures.

Thus, "Abram was very rich in cattle," and "Lot also had flocks and herds," and Isaac "had possession of flocks, and possession of herds." The milk of cattle and their flesh, supply us with food, their skins with leather, which, in early times, were used also for covering the body, as we at this day find among the North American Indians, and the people of the Northern parts of Russia and Asia. Among the people of Asia, especially in the central parts, we find pasturage conducted on the same plan, as we read it was in the days of Abraham. The shepherds dwell in tents, and remove from place to place, to find grass and water for their herds. For, when God said, "Let us make man after Our own image, after Our likeness," he also added, "and let them have dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth, and over every creeping thing that creepeth upon the earth." Gen. i. 26.

2. Agriculture is the art of making the earth to produce in large quantities, and in the greatest perfection of which their nature is capable, those vegetables which are necessary to the subsistence, or useful for the accommodation, of mankind.

Noah was an "husbandman," and scripture abounds with proofs, that agriculture was conducted upon a large

scale, even in those early times, with a view to supply mankind with the necessaries of life. For God said unto Adam, "Behold I have given you every herb bearing seed, which is upon the face of all the earth; and every tree in the which is the fruit of a tree yielding seed; to you it shall be given for meat." Gen. i. 29.

3. In civilized societies, agriculture, or the cultivation of the soil, becomes a separate business or employment; and agriculturists, or the persons engaged in agriculture, receive the appellation of *farmers* or *husbandmen*.

4. Agriculture includes the rearing of cattle, which are used as food in the society of which farmers are members; and they are thus enabled to derive profit from a portion of the land they cultivate.

For as animals, such as oxen, cows, sheep, hogs, fowls, feed on vegetables, the culture of those vegetables in the greatest possible quantities, is the finding of subsistence for a greater number of those animals than the spontaneousness of the earth could afford; and hence, when the husbandman is rearing corn, cultivating grasses, turnips, and other vegetable productions, for the feeding and fattening of cattle and barn-door fowls, he is, as it were, converting the corn, grass, turnips, into the flesh of animals, upon which large bodies of men in cities, in the army, and in the navy live.

Besides it is necessary towards conducting his operations with success, that the farmer should rear and feed oxen and horses, not as a source of human subsistence, but for the sake of the services which they are capable of affording. Horses to the cultivators of the soil, from their strength and patient labour, are particularly useful and even absolutely necessary, in our cold and barren climates; and they must therefore be fed and lodged with the greatest care.

5. The employment of the husbandman is, thence, of an extensive nature, requiring much foresight and a considerable knowledge of the relations that subsist between the most important objects in nature—the *soil*, the *seasons*, the *animals*, and the *plants*, so far as they are connected with the subsistence of mankind;—and it is by bringing to perfection this art that man becomes truly the lord of the universe.

6. The *theory* of agriculture examines, 1st, among the great variety of vegetables that exist in nature, what particular plants ought to be regarded as most worthy of cultivation: and, 2dly, it considers the best mode of cultivating with success the plants thus selected.

Men may feed on fruits and roots; but fruit trees are not to be trusted to for food, because they ripen slowly and are destroyed in war. They rather trust to grain, of which wheat is the most valuable. Of wheat we make bread, puddings, pies, &c. (*See Chap.* v. *art.* 1. *Of Making Bread.* p. 33.)

After wheat oats become a valuable grain, of great importance in our island, for the sustenance both of man and other animals.

Barley is also a very valuable grain from its easy conversion to a saccharine substance, by the process of vegetation or malting, which fits it for the preparation of vinous or spirituous liquors.

Pease are also sometimes used when split or grinded to meal as an article of human food; but on account of their viscid and indigestible quality, they can never become valuable in that point of view, unless to persons engaged in the open air, in the most active and severe kinds of labour.

Of the roots which are used to afford subsistence to

man, the potato has hitherto been the principal. The potato was first brought from America to Ireland by Sir Walter Raleigh in the year 1565, and from thence into England by a vessel wrecked on the western coast, called North Meols, in Lancashire, a place and soil even now famous for producing this vegetable in great perfection.

Of the other roots adapted rather for the purpose of giving variety and relish to other food, and chiefly to butchers' meat, we may reckon carrots, turnips, and parsnips, greens and onions, &c.

7. Of the most proper kinds of vegetables to be raised for the purposes of feeding cattle, cabbages hold the first place, especially what are called the turnip-rooted cabbages. Turnips likewise produce very bulky crops, though far inferior to those of cabbages, but carrots are more beneficial than either.

Cabbages produce on an average 36 tons per acre; turnips, in the finest soil about *five* tons per acre; but an ox of 80 stone weight has been known to eat 210lbs. of cabbages in 24 hours, besides 7lbs. of hay; of turnips the same animal could not possibly eat so many pounds weight. Young's "Farmer's Kalendar."

Carrots are excellent food for cattle of all kinds, and are greatly relished by them. In a rich sandy soil, the produce of this root is 200 bushels an acre; in a finer soil 640 bushels an acre. Carrots are more solid than either cabbages or turnips, and go farther in feeding and fattening cattle. A lean hog will fatten in 10 days on 290lbs. of carrots.

Potatoes likewise appear to be a very palatable food for all kinds of cattle; and not only oxen, hogs, &c. are easily fed by them, but even poultry and roasting pork are never so moist and delicate, as when fed with potatoes, and killed from the barn-doors without any confinement.

Buck wheat is employed to feed hogs; horses are very fond of it, poultry of all sorts are speedily fattened on it, and the blossom of the plant affords food for bees, at that season when the meadows and trees are mostly stripped of their flowers.

Clover and rye grass are well known in the feeding of cattle; but it would exceed the limits of this work to enter at large upon all the hundred kinds of grasses, which animals eat as food in the meadows, or on the mountains; all these grasses are reduced to two great families, natural and artificial grasses; under the latter we reckon ray grass, red clover, trefoil, sanfoil, lucerne, tares, yarrow, turret, &c.

8. The general principles of cultivation embrace, 1st, the nature of the growth of vegetables; 2dly, the different kinds of soils.

Respecting the nature of the growth of vegetables, the husbandman regards them as organized beings, possessed of life, which they derived from other beings that existed previous to themselves; and this former organized being derived its constitution from a parent stem, which grew out of an older plant, up to Gen. 1. 14; where we are told that God said, "Let the earth bring forth grass, the herb yielding seed, and the fruit-tree yielding fruit after his kind, whose seed is in itself upon the earth: and it was so."

As to the different kinds of soils, the husbandman divides them into four kinds, which, though in general mixed with each other, receive their name in ordinary language, from the kind that predominates or is the most abundant. These are sand, clay, chalk, and garden mould; though some divide them into clayey, loamy, chalky, sandy, gravelly, peaty, and moory soils. The clayey and loamy are called stiff or strong soils, in which clover, beans, wheat, cabbages and oats may be cultivated. The sandy and gravelly are light soils, in which potatoes, turnips, pease, oats, and barley may succeed each other; in the equality of one crop for

man, and one for the beasts in his service and for his sustenance.

Note. The destroying of weeds, the improving of soils, the diseases of plants, and the obstacles to agricultural improvements, all which enter the theory of this art, must be learned from Young's "Farmer's Kalendar."

9. The PRACTICE OF AGRICULTURE naturally divides itself into three parts; 1st. The cultivation of vegetable food for men and other animals; 2dly, The cultivation of vegetables, such as flax and hemp, which are more properly articles of commerce; and 3dly, The rearing and management of animals.

10. The instruments of husbandry are the plough, the harrow, the roller, &c. which are again diversified by various constructions adapted to particular uses.

The practice of agriculture considers also the preparing of land for cropping, by removing stones and bushes, draining or rendering it moist by rain or by springs, and all modes of preparation for the receiving of seeds and plants. Again, it considers the rendering of mosses fit for cultivation; the bringing land into culture, from a state of nature; what grounds ought to be formed into ridges, and what ought to be tilled with a flat surface; the clearing of the ground from weeds; the nature of different kinds of soils and the plants proper for each; the rotation of crops; reaping and storing up corn and hay; manures; the preservation and purchase of seeds; timber trees; fencing; cattle proper to be employed; the management of the dairy; the rearing of poultry, hogs, &c.; the making of fruit liquors.

Questions for Examination.

1. What is pasturage? How is its antiquity shown from Scripture? What are its advantages to mankind?
2. Define agriculture, and shew its antiquity.
3. When does agriculture become a separate art?
4. What does it include? and how does the husbandman convert to his profit the cultivation of corn, grasses, turnips, &c.? Also, say how necessary to his service are the rearing and feeding well of oxen and horses.
5. What, then, does the employment of the husbandman require?
6. What does the theory of agriculture include? Now how may men trust for food to fruit trees, to wheat, to barley, to pease, to potatoes, carrots, turnips and parsnips?
7. What are the most proper kinds of vegetables for feeding cattle? What is the estimate per acre of cabbages and turnips? How are carrots excellent food for cattle? How also, potatoes, buck wheat, clover and rye grass?
8. What do the general principles of cultivation embrace? How does the husbandman consider vegetables as organized beings? And what are the different soils he cultivates?
9. Into what does the practice of agriculture divide itself?
10. What are the instruments of husbandry? And what separate branches of rural economy does the practice of agriculture consider?

CHAPTER III.

Of Building, Clothing, and Gardening.

I. OF BUILDING.

1. BUILDING considers the erection of any fabric, either for devotion, magnificence, or convenience. And when we use the term thus, it designates the art of constructing and raising an edifice; in which sense it comprehends as well the expense, as the invention and execution of the design.

Observation. Modern buildings are much more commodious, and much more beautiful, than the rude structures of former times. We speak here of private houses; not of the magnificent structures which come under the name of temples, in ancient Greece and Rome; nor do we make any allusion to Babylon or Egypt. But, in our own country, of old our forefathers dwelt in houses most of them with a *blind* staircase, low ceilings, and dark windows; the rooms built at random, without any regard to convenience, and often with steps from one to another; so that one would think the people of former times were afraid of light and fresh air: whereas the genius of our times is altogether for light staircases, fine sash, or Venetian windows, lofty ceilings, and floors equally level in every separate story of the house. And such has been the builder's industry in point of compactness, and uniformity, that a house after the new way, will afford, on the same surface of ground, almost double the conveniences which could be had from an old one.

2. By Act 11 Geo. i. and 4 Geo. iii. for

the regulation of building within the bills of mortality, and in other places therein specified, party walls are required to be of brick or stone, which shall be two bricks and a half thick in the cellar, two bricks thick upwards to the garret floor, &c. and other limitations are exacted respecting the timbers, &c.

And every building is to be surveyed; and the person who offends against the statute in any of the particulars recited, is liable to a forfeit of 250*l.* to be levied by warrant of Justices of the Peace. The other principal statutes relating to building are 19 Car. ii. c. 3. 22 Car. ii. c. 11. 5 Eliz. c. 4. 35 Eliz. c. 6. 6 Ann. c. 31. 7 Ann. c. 17. 33 Geo. ii. c. 30. and 6 George iii. c. 37.

Note. On this subject see ARCHITECTURE.

Questions for Examination.

1. Describe the art of building—Compare its former practice with the present.

2. What do act 11 George i, and 4 George iii, require for the regulation of building within the bills of mortality and elsewhere? What is the fine for neglecting to have every building surveyed? And what are the different principal statutes relating to building

II. OF CLOTHING.

1. Clothing necessarily considers the cultivation of flax for linens and of sheep for wools, of which to make garments; the arts of *dyeing*, *spinning*, *bleaching*, *weaving*, *fulling*, *dressing*, *&c.*

2. The goodness of cloth, according to some, consists in the following particulars:

1. That the wool be of a good quality and well dressed.

2. It must be equally spun, carefully observing that the thread of the warp be finer and better twisted than that of the woof.

3. The cloth must be well wrought and beaten on the loom, so as to be every where equally compact.

4. The wool must not be finer at one end of the piece than at the rest.

5. The lists must be sufficiently strong, of the same length with the stuff, and must consist of good wool, hair, or ostrich feathers; or, what is still better, of Danish dogs' hair.

6. The cloth must be free from knots and other imperfections.

7. It must be well scoured with fullers' earth, well fulled with the best white soap, and afterwards washed in clear water.

8. The hair or nap must be well drawn out with the teazel, without being too much opened.

9. It must be shorn close without making it thread bare.

10. It must be well dyed.

11. It must not be tenter stretched, to force it to its just dimensions.

12. It must be pressed cold, not hotpressed, the latter being very injurious to woollen cloth.

3. The best wools for the manufacturing of cloths are those of England and Spain, especially those of Lincolnshire and Segovia.

Note. The foregoing particulars embrace the whole process of cloth manufacturing. The detail belongs to as many separate branches of business.

Questions for Examination.

1. What does clothing necessarily consider?
2. What are the several particulars according to which the goodness of cloth consists?
3. What are the best wools for cloth.

III. Of Gardening.

1. The Gardener is chiefly occupied in rearing small quantities of the nicer and more delicate vegetables, which are rather valued as objects of luxury than as articles of food. But, in its utmost extent, whatever contributes to render the scenes of nature delightful is among the subjects of gardening; and animate as well as inanimate objects are circumstances of beauty or character.

The prototype of all gardens, whether we denominate them vineyards, kitchen gardens, orchards, or pleasure gardens, was the garden of Eden. But after the fall of man, a cottage and slip of ground for a cabbage and a gooseberry bush, such as we see by the side of a common, were in all probability the earliest seats and gardens; and a well and bucket succeeded to the Pison and Euphrates. As settlements increased, the orchard and the vineyard followed; and the earliest princes of tribes possessed just the necessaries of a modern farmer.

2. The principles of gardening can only be understood by recollecting that this art is as superior to landscape painting, as a reality to a representation: it is an exertion of fancy; a subject for taste; and being now released from the restraints of regularity, and enlarged beyond the purposes of domestic convenience, the most beautiful, the most simple, the most noble scenes of nature, are all within its province.

For it is no longer confined to the spots from which it takes its name; but regulates also the disposition and

embellishment of a park, a farm, a forest, &c. and the business of a gardener is to select and apply whatever is great, elegant and characteristic in any of them; to discover and to show all the advantages of the place upon which he is employed; to supply its defects, to correct its faults, and to improve its beauties.

3. The materials of gardening may be divided into two general classes, *natural* and *factitious*.

4. The *natural materials* embrace ground, wood, water, rocks.

By *ground* is meant that portion of naked surface which is included within the place to be improved; whether that surface be swamp, lawn, roughet, or broken ground; and whether it be a height, a valley, a plain, or a composition of swells, dips and levels.

By *wood* is meant every species of trees and shrubs in whatever disposition; but it is specifically applied in a more limited sense to *woods, groves,* and *clumps*. And woods are composed both of trees and underwood, while groves exhibit trees without underwood, and a clump differs from either only in extent: it may be either close or open: when close it is sometimes called a thicket; when open, a group of trees; but both are equally thickets, whatever may be the shape or situation.

Water is a general term, comprehending all inland water whether *running* or *stagnant*. The former embraces all rivers, rivulets, rills, streams or currents; the latter all lakes, pools and ponds, bays, creeks, and even promontories.

Rocks are materials of too stubborn a character to submit easily to our control; but by the addition or removal of appendages which we can command, parts may be shown or concealed, and the characters with their impressions may be weakened or enforced; and, therefore, to adopt the accompaniments accordingly, is the utmost ambition of art, when rocks are the subject.

The accompaniments are wood, rivers, rills, cascades, and all such rural scenery as shall give them the expression of dignity, terror, and fancy.

5. The FACTITIOUS *accompaniments* consist of *fences, walks, roads, bridges, seats* and *buildings.*

Though the eye dislikes constraint, the fence, where the place is large, becomes necessary. And the walk in extensive grounds is as necessary as the fence. But the road is either a thing of necessity, as an approach to a mansion, or a matter of pleasure only, as a drive or a ride, from which the grounds and surrounding country may be seen to advantage. Rivers, rivulets, and rills, make bridges necessary; in low situations and where water abounds they are useful and pleasing objects. And every road should if possible answer a two-fold purpose. Seats have also a two-fold use, either as places of rest, and amusement, and conversation, or as guides to the points of view, in which the beauties of the surrounding scenes are disclosed. Buildings in gardens have usually more attention paid to external than to internal appearance; because there they are designed either to distinguish, to break, or to adorn, the scenes to which they are applied.

6. The principles of selection and arrangement in the subjects of gardening include *art, picturesque beauty, character,* and *general arrangement.*

7. And in the execution of the general subjects of gardening as we now view this refined art, all improvements may be classed under the following heads: the *hunting box,* the *ornamented cottage,* the *villa,* and the *principal residence.*

8. HORTICULTURE or practical gardening considers the management of the *kitchen garden,*

the *fruit garden*, the *flower garden* or *pleasure ground*, the *nursery*, the *green-house* and *hot-house*, during every month of the year.

Questions for Examination.

1. Describe to me what gardening is: how the garden of Eden was the prototype of all gardens? how they are considered after the fall? and how they improved as settlements increased?

2. In what respect is gardening superior to landscape painting? and say, what is the business of the gardener?

3. Into what may the materials of gardening be divided?

4. Describe separately the natural materials, ground, wood, water, rocks.

5. Describe, now, separately, the factitious accompaniments, fences, walks, roads, bridges, seats and buildings.

6. What do the principles of selection and arrangement in the subjects of gardening include?

7. What may be classed under the execution of the general subjects of gardening?

8. Describe what is meant by horticulture and what it considers.

CHAPTER IV.

Trade and Commerce.

1. Trade or *commerce* is the buying, selling, and exchanging commodities.

2. Trade derives its origin from two sources:

1. The natural difference in the productions of different countries, according to the varieties of their soils and climates, their mines, and fisheries.

2. From the industry or skill, which the inhabitants exert, in raising, preparing, and manufacturing the materials obtained at home, or imported from abroad.

Illustration. (1.) When a commodity is wanted, in any place where it cannot be raised, or where the superior expense of raising it is greater than that of exportation, trade will naturally take place.

(2.) If the natives neglect it, foreigners, unless restricted, will interfere and transport these commodities in shipping of their own, to places where they can be sold to advantage, and sometimes retain them in their own country, to wait a favourable market.

(3.) But what conduces most to the trade of a nation, is the access it has to the sea; for it has always been found that the more sea coast a nation possesses, the more trade it will command. And the reasons for the sea being the best medium of commerce, or the best mode of conveyance are very obvious. That any nation will command more trade on that account, is evident, not only from its having more easy access to it, but also because the inhabitants daily see and become familiar to storms and shipwrecks, the very idea of which makes the person who lives at a distance from it, think on the sea with disgust.

3. It is from these considerations that GREAT BRITAIN deserves our particular attention, as being confessedly the first maritime nation in the world.

Observation. Surrounded by the sea on every side it has easy access to all the surrounding nations of the earth ; its navy, and the natural bravery of the British character, defend her from all her enemies, while the probity of her merchants, and their extensive traffic, bring the choicest productions of the eastern and western worlds to her feet.

4. The *laws* relating to commercial and maritime affairs approach nearer to uniformity, through the different countries of Europe, than those on other subjects. And the most common mercantile contracts are those between buyer and seller; but we will view them in the following order.

(5.) I. SALE is the exchange of a commodity for money. *Barter,* or permutation, is the exchange of one commodity for another.

Illustration. (1.) When a specific thing is sold, the property even before delivery, is, in some respect vested in the buyer ; and if the thing perish, the buyer must bear the loss ; but, if the bargain only determine the quantity and quality of other goods, without specifying identical articles, and the seller's warehouse with all his goods, be burned, he is entitled to no payment.

(2.) If a person purchase goods at a shop, without agreeing for the price, he is liable for the ordinary market price, at the time of purchase.

(3.) If the buyer prove insolvent before delivery, the seller is not bound to deliver the goods without payment or security.

(4.) ACTIONS for payment of shop accounts, as well

as other debts, not constituted by writing, are limited in *England* to six years. And the testimony of one witness is admitted; even, the seller's books, although the person who kept them be dead, are good evidence for one year.

(5.) In *Scotland* merchants' accounts may be proved, within three years of the date of the last article by one witness, and the creditor's books and oath in supplement. After three years, they can only be proved by the oath or writ of the debtor.

(6.) A merchant's books are in all cases good evidence against him.

(6.) II. PARTNERSHIP is a contract among two or more persons to carry on a certain business, at their joint expense, and share the gain or loss which arises from the business.

Illustration. (1.) *Occasional joint trade* is when two or more merchants agree to employ a sum in trade, and divide the gain or loss so soon as the adventure is brought to an issue. This trade is generally private, and the parties concerned are not liable for each other.

(2.) *A standing company* is that in which two or more merchants are established by written contract; wherein the stock, the firm, duration, the division of the gain or loss, and other circumstances are inserted.

Observation. (1.) The powers of each partner are in general, discretionary; but in all matters of importance, they ought not to act without consulting together, when this can be done.

(2.) No partner is liable to make good the loss arising from his judging wrong, in a case wherein he had authority to act. If he exceed his power, and the event prove unsuccessful, he must bear the loss; but if it prove successful the gain belongs to the company; yet if he acquaint the company immediately of what he has done, they must either acquiesce therein, or leave him to the chance of gain, as well as the risk of loss.

(3.) All debts contracted under the firm of the company are binding on the whole partners, though the money was borrowed by one of them for his private use, without the consent of the rest; and, if a partner exceeds his power, the others are nevertheless obliged to *implement* or make good his engagements, although he is responsible to them for his misbehaviour.

(4.) A debt due to a company is not cancelled by the private debts of the partners; and, when a partner becomes insolvent, the company is not bound for his debts beyond the extent of his share. The debts of the company are preferable, on the company's effects, to the private debts of the partners.

(5.) If a partner dies, the partnership is generally dissolved; yet, when there are more partners than two, it may, by agreement, subsist among the survivors. Sometimes it is stipulated, that in case of the death of a partner, his place shall be supplied by his son, or some other person condescended upon.

(6.) There are often outstanding debts when the partnership is dissolved, that cannot be recovered for a long time, and effects that cannot easily be disposed of. The partnership, though dissolved in other respects, still subsists for the management of their outstanding affairs, and the money arising from them is divided among the partners, or their representatives, when it is recovered.

Illustration. (3.) There are also partnerships in business conducted by officers. They are the same as the former; only, suppose a partner dies, it makes no odds in the business and his share is again sold. The partners take no part in the management of the business, but it is entrusted to officers and persons appointed by them.

(4.) There are likewise companies incorporated by authority. A royal charter is necessary to enable a company to hold lands, to have a common seal, and enjoy the privileges of a corporation. The incorporation of societies is sometimes authorised by act of parliament, but this high authority is not necessary, unless for conferring exclusive privileges.

(7.) III. Factorage. A *factor* is a person employed by merchants residing at other places, to buy or sell goods, or negotiate bills, or transact any kind of business on their account; and he is entitled to a certain allowance for his trouble and time.

Illustration. (1.) The *duty* of a factor is to procure the best intelligence of the state of trade at his place of residence; of the course of exchange; of the quantity and quality of goods at market; their present price, the probability that it may rise or fall; to pay exact obedience to the orders of his employers; to consult their advantage in matters referred to his direction; to execute their business with all the dispatch that circumstances admit; to be early in his intelligence, distinct in his accounts, and punctual in his correspondence.

(2.) If a factor exceed his power, though with a view to his employers' interest, he is liable for the consequence; but although he be limited not to sell the goods under a certain price, and the goods be perishable, and not in a proper state for being kept, he may sell them, to prevent their destruction even under the limited price.

(3.) If a factor save the duty on goods due to a foreign prince, he shall have the benefit; for, if detected, he bears the loss.

(4.) A factor is not liable for goods spoiled, robbed or destroyed by fire.

(5.) If he buy goods for his employer, his bargain shall be binding on his employer.

(6.) In case of the factor's insolvency, the owner may reclaim his goods; and, if they be sold on trust, the owner (and not the factor's creditors) shall recover payment of the debts.

(8). IV. Bills of exchange. Commercial states have long experienced the utility of bills of exchange; and, in order to support their credit,

have afforded every possible security and dispatch to the possessors, and established an uniform rule for deciding controversies which arise concerning them.

(9.) V. OF THE STOCKS AND PUBLIC FUNDS. By the word *stock* was originally meant, a particular sum of money contributed for the establishment of a fund, in order to enable a company to carry on a certain trade, by means of which the person became a partner in that trade, and received a share in the profit made thereby, in proportion to the money employed. This term has been extended farther, to signify any sum of money, which has been lent to the government, on condition of receiving a certain interest till the money is repaid, and which makes a part of the national debt. As the security both of the government and the public companies is esteemed preferable to that of any private person; as the stocks are negotiable, and may be sold at any time; and as the interest is always punctually paid when due; so they are thereby enabled to borrow money on a lower interest, than what might be obtained from lending it to private persons, where there is often some danger of losing both principal and interest.

But as every capital stock or fund of a company is raised for a particular purpose, and limited by government to a certain sum, it necessarily follows, that when that fund is com-

pleted, no stock can be bought of the company; though shares already purchased, may be transferred from one person to another. This being the case, there is frequently a great disproportion between the original value of the shares, and what is given for them when transferred. For if there are more buyers than sellers, a person who is indifferent about selling, will not part with his share without a considerable profit to himself. On the contrary, if many are disposed to sell, and few inclined to buy, the value of such shares will naturally fall, in proportion to the impatience of those who want to turn their stock into specie.

These observations may serve to give some idea of the nature of *stock-jobbing*, the mystery of which consists in nothing more than this. The persons concerned in that practice, and denominated stock-jobbers, make contracts to buy or sell, at a certain distant time, a certain quantity of some particular stock; against which time they endeavour, according as their contract is, either to raise or lower such stock, by spreading rumours, and fictitious stories, in order to induce people either to sell out in a hurry, and consequently cheap, if they are to deliver stock; or to become unwilling to sell it, and consequently to make it dearer, if they are to receive stock.

In general, the persons, who make these contracts are not possessed of any real stock;

and when the time comes that they are to receive or deliver the quantity they have contracted for, they only pay such a sum of money as makes the *difference* between the price the stock was at, when they made the contract, and the price it happens to be at, when the contract is fulfilled. Hence it is no uncommon thing for persons not worth 100*l.* to make contracts, for the buying or selling 100,000*l.* stock. In the language of Exchange Alley, the buyer is in this case called the *Bull*, and the seller the *Bear;* the former is for raising or tossing up, and the latter for lowering or trampling upon the stock.

Besides these, there are other men, who, though of a higher rank, may properly enough come under the same denomination. These are the great monied men, dealers in stock, and contractors with the government, whenever any money is to be borrowed, and they are real buyers and sellers of stock; but by raising false hopes, or creating groundless fears, by pretending to buy or sell large quantities of stock on a sudden, by using the above-mentioned set of men as their instruments, and other like practices, they are enabled to raise or lower stocks one or two per cent. at pleasure.

OF THE MANUFACTURES AND COMMERCE OF THE BRITISH ISLES.

(10.) VI. The earliest staple commodity of England was tin, first introduced into commerce by the

Phœnicians, 500 years before the Christian era. This metal principally abounds in the county of Cornwall, and is very rarely found in other countries.

The woollen manufactories are of great importance, and extend themselves over the whole west-riding of Yorkshire. In Wiltshire, superfine broad-cloths are manufactured.

The manufactories of iron and copper have become great sources of national wealth. Sheffield has long been remarkable for its cutlery ware, and Birmingham, from the variety and beauty of the articles which are manufactured there, has been styled *the toy shop of Europe.*

Elegant earthen ware forms an extensive article of exportation. Staffordshire is the principal seat of this manufacture.

The cotton manufacture is diffused far and wide, forming a grand source of industry and prosperity. Manchester, next in point of opulence to Bristol, owes its importance to it, as does also Glasgow. The Paisley silk gauze has been displayed in court-day dresses. Nottingham is chiefly supported by the weaving of cotton stockings.

The manufactures of glass and fine steel, clocks, watches, &c. are deservedly eminent and extensive.

The English manufactures were recently estimated at the annual value of 63,600,000*l.* and supposed to employ 1,585,000 persons.

11. *The colonies of Great Britain in the East* are Bengal; all the countries on the Ganges, the coasts of Coromandel and Malabar, the islands of Ceylon, Sumatra, &c.—which supply us with spices, silks, rice, coffee, tea, drugs, perfumes, precious stones, cotton, indigo, &c.

12. The *British African* colonies are the Cape of Good Hope, Goree, Sierra Leone, and parts of the Guinea coast; whence we have gold dust, elephants' teeth or ivory, gums, drugs, ostrich feathers, &c.

13. Our *American colonies,* upper and lower Canada, and Nova Scotia, supply us with furs, spars, corn, fish, &c. while our West India Islands send us home rum, cotton, sugar, coffee, spices, drugs, mahogany, sweetmeats, and tropical fruits.

14. Of the foregoing imports we exchange the surplus of our own consumption with Russia for hemp, tar, tallow; with Sweden for copper and timber; with Germany for various kinds of commodities; with France for wine and brandy; with Poland for corn; Portugal, wine; Spain, wine, fruit, gold and silver; Italy, silk, rags, oil, fruit; and with Turkey for silk, carpets, drugs, oil, coffee, &c.

Observation. Hence, besides the East India Company; the Bank of England; the Hudson's Bay Company; the South Sea Company, &c. we have in London Spanish merchants, Italian merchants, Russia merchants, Hamburgh merchants, West Indian merchants, American merchants, Brazil merchants, African merchants; who lately employed 24,000 vessels of all sizes, carrying three millions of tons burden, and employing 200,000 seamen.

Questions for Examination.

1, 2. What is trade? and whence does it derive its origin?

3. How does the trade of Great Britain deserve particular attention?

4. What of the *laws* relating to commerce?

5. What is *sale*? and what laws respect both the seller and buyer?

6. What is *partnership*? What *occasional joint trade*? What a *standing company*, and the rules it must observe?

7. What are the duties of a *factor*?

8. What are the nature and utility of bills of exchange?

9. What also are the nature and practice of the stocks and public funds?

10. What is the extent of the manufactures and commerce of the British Isles?

11. What of our colonies in the East?

12. What do our African colonies supply us with?

13. And what do we receive from our American colonies?

14. What exchanges do we make with Russia, Sweden, Germany, France, Portugal, Spain and Italy? and what are our public companies and merchants, the number and tonnage of shipping and of seamen.

CHAPTER V.

ARTS OF DOMESTIC COMFORT.

Introduction. It is one of the improvements of modern times that the researches of ingenious men are directed into more profitable channels than formerly. Mere abstract science serves only to display the ingenuity of its inventors; it is the application of science to the common purposes of life that renders it truly valuable. And though in this volume we cannot enumerate all the useful arts that have received improvements from modern discoveries, those we shall now describe, take a leading place wherever domestic comfort is desired.

I. Of Making Bread.

1. Bread is generally made of the flour or meal of some farinaceous vegetable, ground, kneaded with water, and leaven, or yeast, or with water alone, and baked by the fire.

Observation. Scarcely any nation lives without bread, or something as a substitute for it; a dry food appearing to be necessary to promote the secretion of saliva in the process of mastication. In Lapland, where they have no corn, they make bread of dried fish, and of the inner rind of the bark of the pine. In America and other countries, they make bread of maize, or Indian corn, and also of cassava, the root of a plant, which is poisonous till it is rendered wholesome by the extraction of its acrid juice. In the South Sea Islands, the bread-fruit tree affords the natives a substance resembling bread. In all civilized countries bread is made from various species of grain, as wheat, barley, oats, rye, buck-wheat, maize, beans, peas, rice and also of potatoes. In times

of scarcity, various other substances have been used, as acorns, chesnuts, turnips, &c.

2. Of all the *farinaceous* substances used for this purpose, WHEAT is found to afford the best bread; and as it is also the most generally used in this country, we shall chiefly confine ourselves to this grain.

Observation. There are three general methods of preparing bread from wheat flour.—1. Unleavened bread. 2. Leavened bread. 3. Bread fermented with yeast.

3. (i.) UNLEAVENED BREAD. When flour is kneaded with water, it forms a tough paste, containing the constituent principles of flour, with very little alteration, and not easily digested by the stomach; when formed into cakes, and baked by heat, the compound is rendered more easy of digestion.

Observation. This mode of preparing bread is by far the most ancient, and it is still used in many parts of the world.

In Scotland the oaten and barley breads are generally made in this manner. Of this kind also is the bread that is eaten by the Jews during the passover.

4. (ii.) LEAVENED BREAD. When flour is kneaded with water, it is called *dough*, and when this is kept in a warm place, it swells up, becomes spongy, and is filled with air bubbles; it disengages at length an acidulous and spiritous smell, tastes sour, and in this state is called *leaven*. Here the saccharine part has been converted into ardent spirit, the mucilage tends to acidity, and the gluten probably verges towards a state of putridity.

Observation. By this incessant fermentation, the mass is rendered more digestable and light. And as soon as the dough has acquired a sufficient bulk from the extrication of carbonic acid gas, it is considered as fit for the oven.

5. (iii.) BREAD MADE WITH YEAST. Yeast is the froth formed upon the surface of beer, or ale, in a state of fermentation, and is composed of carbonic acid gas, inclosed in bubbles of the mucilaginous liquor; when this is mixed with dough, it causes it to ferment and rise better, and more quickly than ordinary leaven; and by this means the best bread is made, as for example, that now most generally used.

6. The method of making *common family bread* is as follows: To half a bushel of flour add six ounces of salt, a pint of yeast, and six quarts of water that has boiled. In warm weather pour in the water that has been boiled when it is nearly cold, but in winter let it be lukewarm. Put all these into a kneading trough, and work them together till they are of the proper consistence of dough. Cover up the dough warm to ferment and rise. This is called *setting the sponge.* After letting it lie a proper time, an hour and a half, more or less, knead it well together, and let it lie some time longer covered up.

The oven must be in the mean time heated: when this is done, and it is properly cleaned, make the bread into loaves, and place them into the oven to bake.

7. HOUSEHOLD BREAD, *or brown bread,* is baked in the same manner, only of flour that is

made from the whole of the wheat, the bran as well as the flour being ground together; whereas, in the white bread, the coarser part of the bran is separated from the flour.

8. FRENCH BREAD is made by putting together a peck and a half of the finest wheaten flour, called Hertfordshire white, a pint of milk, a quarter of a pound of salt, a pint and a half of yeast, a quarter of a pound of butter, two eggs, and three quarts of water; it is baked nearly in the same manner, only frequently turning the bread in the oven.

Questions for Examination.

1. Of what is *bread* generally made by different nations?

2. What is the best *substance* for making bread? And how many methods are there of preparing bread from *wheat flour?*

3. Describe the process of making *unleavened bread.*

4. Inform me how *leavened bread* is made.

5. How does the use of *yeast* make the best bread?

6. Describe the method of making *common family bread.*

7, 8. Also *household* and *French* bread.

II. OF BREWING.

1. The Art of BREWING or of preparing a vinous fermented liquor from farinaceous fluids is very ancient. It was known to the ancient Egyptians, Germans, Spaniards, Gauls, and the inhabitants of the British Isles, and the north of Europe. The liquor made by them, however, resembled more our sweet, and mucilaginous ales, the use of hops being of modern invention.

Observation. The vinous fermentation cannot be produced without saccharine matter; and any substance containing sugar, is capable of producing ardent spirit or alkohol.

2. *Barley* is a natural compound of fecula, or starch, albumen, and a little gluten; and by the process of malting the fecula is converted into sugar: hence it affords a convenient material for the production of *alkohol*, which is the substance that gives the intoxicating quality to every liquor.

3. *Malting*, or the converting of barley into malt is the first process in the making of beer.

4. *Mashing* is the next step in the process of brewing.

5. The next process in brewing is the *boiling* and *hopping*.

6. When the liquor is boiled, it is discharged into a number of *coolers*, or shallow tubs, in which it remains, until it becomes sufficiently cool to be submitted to fermentation.

7. The last operations in brewing are the *tunning* and *barrelling*.

8. For *ales*, the paler kinds of malt are used, and little *hops*, as they are required not to taste bitter. But for *porter*, the brown malts are used, and a larger quantity of hops.

Questions for Examination.

1. Describe the art *brewing*.
2. How does *barley* afford a convenient material for the production of *alkohol?*

3, 4. Define the processes of *malting* and *mashing*.
5, 6, 7. Also of *boiling* and *hopping*, *cooling* and *barrelling*.
8. What kinds of *malt* are used for *ales* and *porter* respectively?

III. Of Bleaching.

1. The art of BLEACHING is of great antiquity. The ancients were acquainted with the detersive quality of some kinds of clay, and the effect produced by the action of the atmosphere, moisture, and light, on the stuffs exposed to them. Health and cleanliness rendered it necessary to devise quicker methods than these; and the property of soaps and leys of ashes were therefore soon discovered.

Observation. In the present age, the arts, following science with close steps, have taken advantage of discoveries which have succeeded each other with such rapidity, that the last twenty years have effected a complete revolution in the art of bleaching.

2. This art is naturally divided into two distinct branches, the bleaching of *vegetable* and of *animal substances*. These being of very different natures, require different processes for whitening them. Vegetables consist of oxygen, hydrogen, and carbon, of which the latter is in the greatest proportion; while animal substances, besides these, contain also a large quantity of azote, and also phosphorus and sulphur.

3. *Steam* has been lately employed in bleaching, with great success, in France. The process was

brought from the Levant. CHAPTAL first made it known to the public of Europe.

Observation. For the use of private families, when the linen is dirtied by perspiration or grease, it will be of great service towards rendering it white, to steep it for some time in a clear liquor, made by mixing one quart of quick-lime in ten gallons of water; letting the mixture stand twenty hours, and using the clean water drawn from the lime. After the linen has been steeped in this liquor, it should be washed as usual, but will require much less soap.

Questions for Examination.

1. Describe the art of *bleaching* anciently and in the present age.
2. Into what *branches* does this art divide itself?
3. How is bleaching by *steam* become popular? What *liquor* is serviceable in family washing for cleansing linen?

IV. DYEING.

1. The substances commonly employed for clothing may be reduced to four; namely, wool, silk, cotton and linen; and the substances employed for dyeing these are called *colouring matters* or *dye stuffs*. They are for the most part extracted from animal and vegetable substances, and have usually the colour, which is intended to be given to the cloth.

Observation. Dyeing then is merely a chemical process, and consists in combining a certain colouring matter with the fibres of cloth. As we have not a sufficient number of colouring matters, with a

strong affinity for cloth, to answer all the purposes of dyeing, we pitch upon a substance that has a strong affinity both for the cloth and the colouring matter. This substance is previously combined with the cloth, which is then dipped into the solution containing the dye stuff. The dye stuff combines with the intermediate substance, which being itself firmly combined with the cloth, secures the permanence of the dye. Substances used for effecting this combination are denominated *mordants*, upon the proper device and application of which the permanency and richness of the colour produced almost entirely depend. Almost the only substances used as mordants are *earths, metallic oxydes, tan* (gall nuts), and *salts;* as alum, &c.

2. Of Dyeing Blue. The colouring matters employed in dyeing blue are *woad* and *indigo, &c.*

Observation. (1.) *Woad* is a plant cultivated in this kingdom, and even growing wild in some parts of England.

(2.) *Indigo* is a blue powder, extracted from a species of plant which is cultivated for that purpose in the East and West Indies.

3. Of Dyeing Yellow. The principal colouring matters for dyeing yellow are *weld, fustic*, and *quercitron bark.*

Observation. (1.) *Weld* is a plant which grows commonly in this country.

(2.) *Fustic* is the wood of a large tree which grows in the West Indies.

(3.) *Quercitron* is a tree growing naturally in North America, the bark of which contains the colouring matter.

4. Of Dyeing Red. The colouring matters employed for dyeing red, are *kermes, cochineal,*

archil, madder, carthemus, brazil-wood, lac, and *logwood.*

Observation. (1.) *Kermis* is a species of insect, affording a red colour by solution in water, but it is not so beautiful as *Cochineal,* which is likewise an insect brought from Spain and America. The decoction of cochineal is a very beautiful crimson colour.

(2.) *Archil* is a paste formed of a species of lichen pounded, and kept moist for some time with stale urine.

(3.) *Madder* is the root of a well known plant (rubia tinctorium).

(4.) *Carthemus* is the flower of a plant cultivated in Spain and the Levant.

(5.) *Brazil-wood* is the wood of a tree growing in America and the West Indies. Its decoction is a fine red colour.

(6.) *Lac* is the production of an insect brought from India. The decoction of it in water gives a deep crimson colour.

(7.) *Logwood,* called also *Campeachy wood,* is a wood that grows in Jamaica, and the bay of Campeachy. It gives out its colouring matter, which is of a fine red, copiously to alkohol, and more sparingly to water.

5. Of Dyeing Black. The substances employed to give a black colour to cloth are, *red oxyde of iron,* and *tan.* These two substances have a strong affinity for each other; and when combined assume a deep black colour, not liable to be destroyed by the action of air or light.

6. Of Dyeing Brown. Brown or fawn colour, though in fact a compound, is usually ranked among the simple colours, because it is applied to cloth by a single process. Various substances are used for brown dyes.

7. Of Dyeing Compound Colours. Compound colours are produced by mixing together two simple ones; or, which is the same thing, by dyeing cloth first one simple colour, and then another. These colours vary to infinity, according to the proportions of the ingredients employed. They may be arranged under the following classes:

1. Mixtures of blue and yellow; 2. blue and red; 3. yellow and red; 4. black and other colours.

Mixtures of blue and yellow form *green.*

Mixtures of blue and red form different shades of *violet, purple* and *lilac.*

Mixtures of yellow and red produce *orange.*

Mixtures of black with other colours, constitute *greys, drabs,* and *browns.*

Questions for Examination.

1. What substances are principally used for *clothing?* what substances are used for *colouring* these? and how is *dyeing* then a chemical process?

2. Describe the method, and materials used, for *dyeing blue.*

3. Also the method and materials for *yellow.*

4. Likewise the method and materials for *red.*

5. And the process and materials for *black.*

6. Also the method and materials for *brown.*

7. Likewise the dyeing of *compound colours;* and the classes under which you range the *mixtures.* Now say, what colours are produced; 1. by the mixture of *blue* and *yellow;* 2. *blue* and *red;* 3. *yellow* and *red;* and 4. *black* with *other colours.*

V. Calico Printing.

1. Calico Printing is the art of communicating different colours to particular spots or figures, on the surface of cotton or linen cloth, while the rest of the stuff retains its original whiteness.

Observation. This ingenious art seems to have originated in India, where we know it has been practised for more than 2000 years. It has but lately been cultivated in Europe, but the enlightened industry of our manufacturers has already improved prodigiously upon the tedious processes of their Indian masters. No art has arisen to perfection with greater celerity: a hundred years ago it was scarcely known in Europe; at present the elegance of the patterns, the beauty and permanence of the colours, and the expedition with which the different operations are carried on, are really admirable.

2. The mordants employed in calico printing are acetite of alumine and acetite of iron.

3. When the cloth, after being impregnated with the mordant is sufficiently cleansed, it is dyed in the usual manner.

Questions for Examination.

1. Define *calico printing*; its *origin* in India, and *progress* in Europe at present.
2. What are the *mordants* employed in calico printing?
3. When and how are calicoes dyed?

VI. Tanning and Currying.

1. Tanning is the art of converting the raw skins of animals into *leather*.

2. The leather tanned in England consists chiefly of three sorts, known by the name of *butts* or *backs*, *hides* and *skins*.

Observation. *Butts* are generally made from the stoutest and heaviest ox hides.

3. The whole process requires from eleven to eighteen months, and sometimes two years, according to the substance of the hide, and discretion of the tanner.

4. The leather which goes under the denomination of *hides*, is generally made of cow hides, or the lighter ox hides.

5. *Skins* are the general term for the skins of calves, seals, hogs, dogs, &c.

6. The art of Currying consists in rendering tanned skins supple and of uniform density, and impregnating them with oil, so as to render them in a great degree impervious to water.

Observation. (1.) Such skins as are intended for the upper leathers and quarters of shoes, for the legs of boots, for coach and harness leather, saddles, and other things, must be subjected to the process of currying.

(2.) After the skins are curried, it may be required to colour them. The colours usually given to them are *black, white, red, green, yellow, &c.*

Questions for Examination.

1. Define the art of *tanning*.
2. Of what does the *leather* tanned in England consist?
3. What *time* does the whole process require?
4, 5. What are *hides* and *skins?*
6. Describe the art and process of *currying*.

VII. THE MANUFACTURE OF SODA AND POTASH, &c.

1. SODA, or the mineral alkali, is sometimes found in a native state, as in the lakes of Natron in Egypt, which are dry in the summer season: the water leaving after evaporation a bed of Soda, or, as it is there called *natron*, of two feet in thickness.

Observation. (1.) A marine plant, called the *Salsola Soda*, which grows among the cliffs on the sea coast, seems to be endowed by nature with the property of decomposing the salt water, that is, of separating the muriatic acid from the soda, which latter it absorbs. This plant is collected by the Spaniards with great care, and burnt for the manufacture of *barilla*, which is a carbonate of Soda mixed with various impurities.

(2.) Soda is also procured in a still more impure state by the burning of the sea-weeds on our own shores, particularly in Scotland, from which is produced a substance called *Kelp*.

2. POTASH exists as an ingredient, in very small quantity, in many minerals. It is also obtained from the tartar, or from lees of wine, in which it is called *salt of tartar*. But the great

supply of this substance is procured from the ashes of burnt vegetables.

Observation. In many districts of England and Ireland, they burn the common fern to ashes, which they mould up with a little water into balls of about three or four inches in diameter, these are called *ash balls.*

3. The *potash of commerce*, or *black potash* is always procured from the combustion of wood, and can therefore only be made in those countries where wood is very plentiful, as Poland, Russia, Germany and America.

Observation. The ashes of burnt wood are put into a cistern with water and a strong lixivium is made. After a time, the water holding the alkali in solution, is drawn off, leaving the impurities behind.

4. Potash is converted into a purer state by calcining it in a reverberatory furnace. It becomes then dry, parous, considerably caustic, extremely deliquescent, and of a beautiful bluish colour, from which it is called *pearl ash.*

Questions for Examination.

1. Define what *soda* is; where procured; and of what, and by whom *barilla* is manufactured.
2. Of what is *potash* manufactured?
3. How is the *potash of commerce* procured?
4. How is *pearl ash* made?

VIII. Refining Metals.

Refining Metals. The term refining signifies the purification of some substance, by which we mean the separation of gold, silver, and copper from each other; and obtaining each of them in a pure state.

Question. How are *metals* refined?

IX. THE MANUFACTURE OF POTTERY.

1. POTTERY, or the art of making vessels of baked earth, is of the remotest antiquity. The ancient Greeks and Etruscans particularly excelled in it. Porcelain, the most perfect species of pottery, has been made in China from time immemorial.

2. ALUMINE and SILEX are two substances of which every kind of earthenware is made. Clay alone shrinks and cracks, the flint gives it solidity and strength.

3. *Common pottery*, such as coarse brown jugs &c., are made of the ordinary clays, which are a mixture of sand and clay coloured by oxyde of iron.

Illustration. The clay is well ground, or kneaded, and a lump of it is put upon the centre of a wheel which is kept in motion; then by means of the workman's hand, or by proper tools it is formed into the proposed shape. The pieces are then dried moderately, so as to bear being removed without danger; they are now covered with a glaze, made from semi-vitreous oxyde of lead, and put into a furnace, where they are baked. Some sorts are glazed by throwing salt into the furnace among the different pieces of pottery. The salt is decomposed, and the vapours of it form a glazing upon the vessels: but this though a very simple and ingenious method, does not form a good glazing.

4. *English stone-ware* is made of tobacco-pipe clay, mixed with flints calcined and ground.

5. *Porcelain*, or *China*, is a semi-vitrified earthenware of an intermediate nature, between common ware and glass.

6. *Delft-ware*, so called because first made at Delft in Holland, is a kind of pottery made of sand and clay, and but slightly baked, so that it resists the sudden application of heat.

7. *Tobacco-pipes* require a very firm, tenacious clay, which is either naturally of a perfectly white colour, or, if it have somewhat of a grey cast, will necessarily burn white.

Questions for Examination.

1. Of what is *pottery* the art?
2. What *substances* are chiefly used in the manufacture of pottery?
3. Describe the process of making *common pottery*?
4, 5. Also *English stone-ware* and *porcelain*.
6, 7. Likewise *Delft-ware* and *tobacco-pipes*.

X. THE MANUFACTURE OF GLASS.

1. This beautiful material is not of modern invention; it was discovered by the Phœnicians and known to the ancient Romans, but it was by no means common among them; and they do not appear to have had the method of forming it into vessels of various, and so magnificent shapes as is practised at present.

2. GLASS is made by fusing together silex and potash, or soda, in proper proportions. Sea sand,

which consists almost entirely of quartz and flints reduced to powder, is generally used for this purpose.

Observation. When the ingredients of which glass is composed are perfectly fused, and have acquired a certain degree of heat, which is known by the fluidity of the mass, part of the melted matter is taken out at the end of a long hollow tube which is dipped into it, and turned about till a sufficient quantity is taken up; the workman then rolls it gently upon a piece of iron to unite it more intimately. He then blows through the tube, till the melted mass at the extremity swells into a bubble, after which he rolls it again on a smooth surface to polish it, and repeats the blowing until the glass is brought as near the size and form of the vessel required as he thinks necessary.

3. *Window-glass* is made in a similar manner, except that the liquid mass at the end of the tube is formed into a cylindrical shape, which being cut longitudinally by scissars or sheers is gradually bent back until it becomes a flat plate.

4. *Large plate-glass for looking-glasses,* &c. is made by suffering the mass, in a state of complete fusion, to flow upon a table, with iron ledges to confine the melted matter, and as it cools, a metallic roller is passed over it, to reduce it to an uniform thickness. There are various kinds of glass manufactured for different purposes, the principal of these are flint-glass, crown-glass, and bottle-glass.

5. *Flint-glass* is the densest, most transparent, colourless and beautiful. It is sometimes called *crystal.*

6. *Crown-glass* differs from the last in containing no lead. It is made of soda and fine sand. It is used for panes of windows, &c.

7. *Bottle-glass* is the coarsest sort of all. It is made from kelp and common sand. Its green colour is owing to iron. It is the least fusible.

Questions for Examination.

1. By whom was the manufacture of *glass* discovered? and what knew the Romans of this art?
2. Describe *how* glass is made, and also the *materials* used in its manufacture.
3. How is *window*-glass made?
4. And how *large plate*-glass?
5. Likewise *flint*-glass.

6, 7. Also *crown* and *bottle*-glass.

XI. Varnishing, Japanning, Gilding, &c.

1. By Varnish is meant a clear limpid fluid, capable of hardening, without losing its transparency; used by painters, gilders, &c. to give a lustre to their works, and to preserve and defend them from the air and moisture.

Observation. A coat of varnish ought to possess the following properties; 1. It must exclude the action of the air; because wood and metals are varnished to defend them from decay and rust. 2. It must resist water, for otherwise the effect of the varnish could not be permanent. 3. It ought not to alter such colours as are intended to be preserved by these means.

2. *Resins* form the basis of every varnish. For this purpose they must be dissolved, as minutely divided as possible, and combined in such a manner, that the imperfections of those that might be disposed to scale, may be corrected by others.

Observation. Resins may be dissolved by three agents; 1. By *fixed*, or *fat oil;* 2. By *volatile*, or *essential oil*: 3. By *spirit of wine*. Accordingly we have three kinds of varnish: *fat*, or *oily varnish, essential oil varnish;* and *spirit varnish.*

3. JAPANNING is properly the art of varnishing and painting ornaments on wood, in the same manner, as is done by the natives of Japan in the East Indies.

Observation. The substances which admit of being japanned are almost every kind that are dry and rigid, or not too flexible, as wood, metals, leather, and paper prepared.

4. LACQUERING is the laying either coloured or transparent varnishes upon metals, in order to produce the appearance of a different colour in the metal, or preserve it from rust, or the injuries of the weather.

Observation. (1.) Lacquering is used where brass is to be made to have the appearance of being gilt; where tin is wanted to have the resemblance of yellow metals; and where brass locks or nails, or other such matters, are to be defended from the corrosion of the air or moisture.

(2.) The principal substance used for the composition of lacquers is seed-lac; but for coarser purposes, resin or turpentine is added in order to make the lacquer cheaper.

5. GILDING is the application of gold to the surfaces of bodies; of which there are two methods according to the way of applying the gold.

Observation. (1.) Wood, leather, paper, and similar substances, are gilt by fastening on leaves of gold by means of some cement. But metals are gilt by a chemical application of the gold to the surface. This last is called *water gilding*.

(2.) The gilding of wood, and similar substances, is of three kinds; *oil-gilding*, *burnished gilding*, and *japanners' gilding*.

6. SILVERING. Wood, paper, &c. are silvered in the same manner as gilding is performed, using only silver instead of gold leaf.

7. TINNING is the art of covering any metal with a thin coating of tin. Copper and iron are the metals most commonly tinned. The use of tinning these metals is to prevent them from being corroded by rust, as tin is not so easily acted upon by the air or water, as iron and copper are.

Observation. (1.) What are commonly called tin-plates or sheets, so much used for utensils of various kinds, are in fact iron plates coated with tin.

(2.) The principal circumstance in the art of tinning, is, to have the surfaces of the metal to be tinned perfectly clean and free from rust, and also, that the melted tin be perfectly metallic, and not covered with any ashes, or oxyde of tin.

8. BRONZING is colouring plaister, or other busts, and figures with metallic powders in order to make them appear as if made of copper, or other metals.

Observation. The powders used for this purpose, are either fine copper filings, aurum musivum, or copper precipitated from its solution in aqua fortis by iron. Having done over the substance to be bronzed with either isinglass-size, japanners' gold size, or, in some cases, with drying oil, or oil paint; the powders are rubbed on, taking care that the projecting parts receive more of the powder than the cavities, to imitate the brightness of bronze on those parts that are liable to be rubbed.

9. SOLDERING is the art of joining two pieces of metal together by heating them, with a thin piece or plate of metal interposed between them. Thus tin is a solder for lead; brass, gold, or silver, are solders for iron, &c.

Questions for Examination.

1. What is meant by *varnish?* and what *properties* ought a coat of varnish to possess?
2. What process must *resins* (the bases of every varnish) undergo to prepare them for varnishes? and by what agents may they be dissolved?
3. What is *japanning* and what *substances* admit of being japanned?
4. What is *lacquering*, where used, and of what *substances* composed?
5. Describe the process of *gilding*.
6. Also that of *silvering*.
7. Of what is *tinning* the art? what are *tin plates?* and what is the principal *circumstance* in the art of tinning?
8. Describe the process of *bronzing*.
9. Also the art of *soldering*.

XII. MOULDING AND CASTING.

1. The art of taking casts or impressions from pieces of sculpture, medals, &c. is of very great importance in the fine arts.

Observation. In order to procure a copy or cast from any figure, bust, medal, &c. it is necessary to obtain a mould, by pressing upon the thing to be moulded, or copied, some substance, which, when soft, is capable of being forced into all the cavities or hollows of the sculpture. When this mould is dry and hard, some substance is poured into it which will fill all the cavities of the mould, and represent the form of the original from which the mould was taken.

Question. What is the process adopted in taking *casts*?

XIII. Of Cements.

1. Cements require to be of various compositions, according to the substances to which they are applied, and whether they are to be exposed and moistened.

2. *Common glue* is formed by extracting the gelatinous part of cuttings or scraps of coarse leather, or the hides of beasts.

3. *Isinglass glue* is made by dissolving beaten isinglass in water by boiling, and having strained it through a coarse linen cloth, evaporating it again to such a consistence, that being cold, the glue will be perfectly hard and dry.

4. *Parchment glue.* Take one pound of shreds of parchment or vellum, and boil it in six quarts of water, till the quantity be reduced to one quart, strain off the fluid from the dregs and then boil it again till it be of the consistence of glue.

Observation. The same may be done with glovers

cuttings of leather, which are dressed with alum instead of being tanned; this will make a colourless glue.

5. *Flour paste* for cementing is formed principally of wheaten flour, boiled in water till it be of a glutinous or viscid consistence.

6. *Common size* is manufactured in the same manner, and generally by the same people as glue.

7. *Isinglass size* may also be prepared in the manner above directed for the glue, by increasing the proportion of the water for dissolving it. And the same holds good of parchment size.

Questions for Examination.

1. Of what compositions do *cements* require to be?
2. How is *common glue* made?
3. How also is *isinglass* made?
4. How likewise *parchment glue*?
5. Of what is *fine paste* made?
6, 7. Of what *common* and *isinglass* size?

XIV. Ink Making.

1. Inks are fluid compounds, intended to form characters, or some other kinds of figures, on proper grounds of paper, parchment, or such other substance as may be fit to receive them.

2. There are two principal kinds of ink, writing and printing ink.

Illustration. (1.) *To make black writing ink.* Take eight ounces of Aleppo galls in coarse powder; four ounces of logwood in thin chips; four ounces of sulphate of

iron (green copperas); three ounces of gum arabic in powder, one ounce of sulphate of copper (blue vitriol); and one ounce of sugar candy. Boil the galls and logwood together in twelve pounds of water for one hour, or till half the liquid has been evapoured. Strain the decoction through a hair sieve, or linen cloth, and then add the other ingredients. Stir the mixture till the whole is dissolved, more especially the gum; after which leave it to subside for twenty four hours, then decant the ink and preserve it in bottles of glass or stone-ware, well corked.

(2.) *Red writing ink* is made in the following manner: Take of the raspings of brazil-wood a quarter of a pound, and infuse them two or three days in vinegar. Boil the infusion for an hour over a gentle fire, and afterwards filter it while hot. Put it again over the fire, and dissolve in it, first, half an ounce of gum arabic, and afterwards of alum and white sugar, each half an ounce.

(3.) *Printer's ink* is a black paint composed of lamp black and linseed or sweet oil boiled so as to acquire considerable consistence and tenacity. The art of preparing it is kept a secret; but the obtaining good lamp black appears to be the chief difficulty in making it.

The ink used by copper-plate printers differs from the last, only in the oil not being so much boiled, and the black which is used being Frankfort black.

3. SYMPATHETIC INKS are such as do not appear after they are written with, but which may be made to appear at pleasure. A variety of substances have been used for this purpose. We shall describe three of the numerous methods of writing with sympathetic inks.

Illustration. (1.) Write with a solution of sulphate of iron, and nothing will be visible. To render it so, rub it over with a feather dipped in a decoction of gall-nuts, and the letters will instantly appear black.

2. *Green sympathetic ink.* Dissolve cobalt in nitro-muriatic acid, and write with the solution. The letters will be invisible till held to the fire, when they will appear green, and will disappear completely again when removed into the cold. In this manner they may be made to appear and disappear at pleasure.

Observation. A very pleasant experiment of this kind, is, to make a drawing representing a winter scene, in which the trees appear void of leaves, and to put the leaves on with this sympathetic ink; then, upon holding the drawing near to the fire, the leaves will begin to appear in all the verdure of spring, and will very much surprise those who are not in the secret.

Illustration. (3.) *Blue sympathetic ink.* Dissolve cobalt in nitric acid, precipitate the cobalt by potash; dissolve this precipitated oxyde of cobalt in acetic acid, and add to the solution one-eighth of common salt. This will form a sympathetic ink, which, when cold, will be invisible, but will appear blue by heat.

4. *To remove ink stains.* The stains of ink on cloth, paper or wood, may be removed by almost all acids; but those acids are to be preferred which are least likely to injure the texture of the stained substance.

Illustration. The muriatic acid, diluted with five or six times its weight of water, may be applied to the spot, and after a minute or two may be washed off, repeating the application as often as may be found necessary. But the vegetable acids are attended with less risk, and are equally effectual. A solution of the oxalic, citric (acid of lemons), or tartareous acids in water, may be applied to the most delicate fabrics without any danger of injuring them; and the same solutions will discharge writing, but not printing ink. Hence they may be employed in cleaning books which have been defaced by writing on the margin, without impairing the text. Lemon-juice and the juice of sorrels, will

also remove ink stains, but not so easily as the concrete acid of lemons, or citric acid.

5. *To remove iron stains.* These may be occasioned either by ink stains, which on the application of the soap are changed into iron stains, or by the direct contact of rusted iron. They may be removed by diluted muriatic acid, or by one of the vegetable acids already mentioned.

6. *To remove the stains of fruit and wine.* These are best removed by a watery solution of the oxygenated muriatic acid, or by that of oxygenated muriate of potash or lime, to which a little sulphuric acid has been added.

7. *To remove spots of grease from cloth.* Spots of grease may be removed by a diluted solution of potash, but this must be cautiously applied to prevent injury to the cloth. Stains of white wax, which sometimes fall upon the clothes from wax candles, are removeable by spirits of turpentine, or sulphuric ether. The marks of white paint may also be discharged by the last mentioned agents.

Questions for Examination.

1. What is the use of inks?
2. How is black writing ink made? How also red writing ink? And how also printers' ink?
3. What is sympathetic ink?
4. How do you make black sympathetic ink?

5. How is green sympathetic ink made?
6. How also is blue sympathetic ink made?
7. And what application of greén sympathetic ink is made to drawing a winter scene?
8. How are ink stains removed?
9. What acids are preferred for removing them?
5. How also do you remove iron stains?
6. Also the stains of fruit and wine?
7. And likewise spots of grease?

CHAPTER VI.

Of Geography.

1. *Geographical Definitions.*

1. Geography is the science which treats of the earth, the surface of which contains *land* and *water*.

2. A great extent of land is called a *continent*, of which there are two; one contains *Europe, Asia,* and *Africa;* and the other contains *America;* these are called the *four quarters* of the world. The former is also called the *eastern*, and the latter the *western* continent.

3. An *island* is an extent of land surrounded by the sea, as *Great Britain, Jamaica, &c.*

4. A *peninsula* is a tract of land every where surrounded by water, except at one narrow neck, by which it is joined to some other land. This narrow neck is called an *isthmus.*

5. *A promontory* is a point of land stretching far into the sea, the end of which is called a *cape*, as the *Cape of Good Hope.*

6. The great collection of water is called the *sea* or *ocean*, and is divided into three principal parts; the *Atlantic Ocean*, which divides *Europe* and *Africa* from *America;* the *Pacific Ocean* or *Great South Sea*, which divides *Asia* from *America*, and the *Indian Ocean*, which lies east of *Africa* and south of *Asia.*

7. Besides these, there are many small seas, some of which take their names from the countries against which they are situated; as the *Irish Sea*, the *German Sea, &c.*

8. A *gulf* or *bay* is an arm of the sea running into the land, as the *Bay of Biscay*, the *Gulf of Bothnia, &c.*

Observation. If a gulf be very large, it is called an *inland sea*; thus, the *Gulf of Venice* is sometimes called *the Adriatic Sea.* A small bay is called a *creek* or *haven.*

9. A *strait* is a narrow part of the sea, flowing between two countries, and connecting two seas; as the *Strait of Dover*, the *Strait of Gibraltar*, &c.

10. A *lake* is a considerable body of inland fresh water; as the *Lake of Geneva*, *Lake Ontario*, &c.

11. A considerable stream of inland water, which runs into the sea, is called a *river*.

General Survey of the Earth.

12. The surface of the earth contains 198,956,786 square miles, more than two-thirds of which are covered with water.

13. The seas and unknown parts are said to contain 159,966,217 square miles, and the inhabited parts 38,990,569, of which

Europe contains	4,456,065
Asia	10,768,823
Africa	9,654,807
America	14,110,874
Total	38,990,569

14. The following has been given as an estimate of the population of the globe:

Asia contains	500,000,000	souls
Europe	150,000,000	
Africa	30,000,000	
America	20,000,000	
Austral Asia, Polynesia, and Isles in the Pacific Ocean	500,000	
Total	700,500,000	

15. Admitting the above calculations to be accurate, the population to every square mile will be, to Europe, 34 nearly, to Asia 46, to Africa 3, and in America there are only 3 inhabitants to every 2 square miles.

Questions for Examination.

1. Define Geography.

2. Define a Continent: 3. An Island: 4. A Peninsula: 5. A Promontory: 6. An Ocean: 7. A Sea: 8. A Gulf: 9. A Strait: 10. A Lake: 11. A River.

12. What number of square miles does the surface of the earth contain?

13. How many are allotted to seas, and how many to inhabited parts? Now what is the superficial content of Europe, Asia, Africa and America respectively?

14. What is the population of Asia, Europe, Africa, America, and Austral Asia respectively? What is then the entire population of the earth?

II. EUROPE.

1. Europe, the smallest of the four great divisions or quarters of the world, is situated between the 10th degree west and the 60th degree east longitude from London; and between the 36th and 72d degree of north latitude.

Observation. It is bounded on the north by the Frozen Ocean; on the east by Asia; on the south by the Mediterranean Sea, which divides it from Africa; and on the west by the Atlantic Ocean, which separates it from America. Its length from east to west, is about 3,300 British miles, and its breadth from north to south about 2,350.

European States.

2. The chief countries of Europe are, four in the north, six in the middle, and four in the south.

1. *Four in the North.*

Countries	Chief Towns	Situated
The British Isles	London	On the river Thames
The Danish Dominions	Copenhagen	On the Sound
Sweden	Stockholm	On Lake Mæler
Russia	Petersburgh	On the river Neva.

2. *Six in the Middle.*

France	Paris	On the river Seine
Batavia or Holland	Amsterdam	On the river Amstel
Switzerland	Basil	On the river Rhine
Germany		
Austrian Dominions,	Vienna and Presburg	On the river Danube
Prussia,	Berlin	On the river Spree

3. *Four in the South.*

Spain	Madrid	On the river Manzanares
Portugal	Lisbon	On the river Tagus
Italy	Rome	On the river Tiber
Turkey	Constantinople	On the Strait of Constantinople.

3. The Oceans and Seas contiguous to Europe, are

1st, The Atlantic Ocean on the west, which divides Europe from North America; 2d, The Frozen Ocean on the north; 3d, The Mediterranean sea, which divides Europe from Africa: the eastern part of the Mediterranean is frequently called the Levant.

4. The smaller seas are,

1st, The White Sea, on the north of Russia; 2d, the Baltic, between Denmark, Sweden, Russia, Prussia and Germany; 3d, the German or North Sea, between Britain, Denmark and Germany; 4th, the Irish Sea, the southern part of which is called St. George's Channel, between England and Ireland; 5th, the English Channel between England and France; 6th, the Adriatic Sea, or Gulf of Venice, rolling its waters between Italy and Turkey; 7th, the Archipelago; 8th, the sea of Marmora; 9th, the Black Sea; and 10th, the Sea of Azof, between Europe and Asia.

5. The principal Bays, Gulfs, and Straits.

There are four large gulfs, and six small.

(1.) The larger gulfs are, the Gulf of Bothnia, in Sweden; the Gulf of Finland, between Sweden and Russia; the Bay of Biscay, between France and Spain; and the Gulf of Venice, between Italy and Turkey.

(2.) The smaller gulfs are, the Gulfs of Riga and Dantzick, in the Baltic; and the Gulfs of Lyons, Genoa, and Salonica, in the Mediterranean.

(3.) The straits are the Sound, between Denmark and Sweden; the Strait of Dover, between England and France; the Strait of Gibraltar, between Spain and Africa; the Strait of Messina, between Sicily and Italy; the Strait of Gallipoli, forming the entrance into the Black Sea; and the Strait of Kaffa, forming the entrance into the sea of Azof.

6. The principal Lakes and Mountains.

The lakes are Onega, Ladoga, and Peypus in Russia, Wener, and Weter in Sweden; Neufchatel and Geneva, on the borders of France; and Lucerne, Zurich, and Constance, in Switzerland.

The chief mountains are the Alps, in Switzerland, which extend in a semicircular form for above 500 miles; the highest part, Mount Blanc is 15,662 feet above the level of the sea; the Pyrenees, between France and Spain, the greatest height of which is 11,000 feet; the Apennines in Italy; the Carpathian Mountains, which run for nearly 500 miles to the north and east of Hungary, and the Langfiall, or Long Mountains, which separate Norway from Sweden.

7. The Volcanos in Europe are,

Mount Etna in Sicily, whose base covers a space of 180 miles, and its height above the sea, is 11,000 feet: the crater of Etna is often 3 miles in circumference: Mount Vesuvius, east of Naples, is about 3,600 feet high; and Mount Hecla in Iceland, 5000 feet above the Sea.

8. Rivers of Europe are,

The Dwina, the Duna, the Niemen, the Vistula, the Oder, the Elbe, the Vilesor, the river Eems, the Rhine, the Schelde, the Maise, the Seine, the Loire, the Garonne, the Minho, the Douro, the Tagus, the Guadiana, the Guadalquaver, the Ebro, the Rhone, the Arno, the Tiber, the Po, the Adige, the Danube, the Inn, the Beresina, the Niester, the Dnieper, the Don, the Wolga.

Observation. These rivers may easily be traced on a good map.

9. The European Islands are, in the Baltic,

Rugen, Rand, Gothland and Aland, belonging to Sweden; Zealand, Funen, Alsen, Langtand, Leeland,

Falster, Femeren, and Bornholm belonging to Denmark, and Dago and Oesel are the property of Russia.

Nova Zembla, in the Frozen Ocean, belongs to Russia; and Iceland to Denmark.

10. In the Atlantic Ocean are,

The large Islands of Great Britain and Ireland. The Orkney and Shetland Islands to the north of Scotland, the Hebrides to the west of Scotland; and the Ferro Isles to the north of the Shetland Islands, belong to Denmark.

The Azore Islands in this ocean properly belong to Europe; and the principal are, St. Michael, Tercera, Pico, Fayal, Florez and Corvo, under the government of Portugal.

11. In the Irish sea

We find the Isles of Man and Anglesea. The Isles of Wight, Jersey, Guernsey, Sark, and Alderney, are in the British Channel.

12. In the Mediterranean are,

The islands of Minorca, Mallorca (Majorca), and Iviza, off the coast of Spain, to which they belong. Corsica belongs to France, Sardinia is a separate kingdom, and Sicily belongs to Naples. South-east of Sicily lies the small Island of Malta, now in possession of the English, and a place of great strength. Candia, with the Islands of the Archipelago, are to the south and east of Turkey.

13. THE ISTHMUSES are those of Corinth between the Morea and Turkey, and of Precops, in the Crimea.

14. CAPES. The principal in Europe are,

The north cape in Lapland; the Naze in Norway; Land's End in England; Cape Clear in Ireland; Cape

La Hogue in France; Cape Ortogal and Cape Finisterre in Spain; Cape St. Vincent in Portugal; Cape Spartivento in Italy, and Cape Matapan in Turkey.

Questions for Examination.

1. What is the geographical position of Europe, and how is it bounded?

2. What are the chief countries, their chief towns, and the rivers they are situated on, in the north, the middle, and the south of Europe?

3, 4. What are the oceans and seas contiguous to Europe?

5. What are the principal bays, gulfs, and straits?

6. What also are the principal lakes and mountains?

7, 8. What are the volcanos and rivers?

9, 10, 11, 12. What are the islands in the Baltic Sea? the Frozen Ocean? the Atlantic? the Irish Sea, and the Mediterranean?

13, 14. What are the isthmuses? What the capes?

The British Islands.

1. Great Britain extends from 50 to $58\frac{1}{2}$ degrees north latitude, and from 2 degrees east, to 6 degrees west longitude. Its length may be computed at 580, and its breadth at 370 British miles.

2. England with Wales is bounded on the east by the German Ocean, or the North Sea, on the south by the English Channel, on the west by the Irish Sea, and on the north by Scotland, from which it is separated by the rivers Esk and Tweed, the Cheviot Hills, and an ideal line falling down south-west to Solway Frith.

Observation. The extent of England and Wales, in

square miles is computed at 49,450 ; and the population being estimated at 9,500,000, the number of inhabitants to a square mile will be 192.

3. SCOTLAND.—That part of Great Britain called Scotland, is 260 miles in length, by about 160 miles at its greatest breadth; it extends from the 55th degree of north latitude, to more than 58½ north.

Observation. The superficial contents of Scotland have been computed at 27,793 square miles. The population being estimated at 1,600,000 souls, there will of course be only 57 inhabitants for every square mile.

4. IRELAND lies to the west of Great Britain, and is about 300 miles in length, and about 182 at its greatest breadth.

Observation. The superficial contents may be computed at 30,370 square miles, and the population being estimated at 5,000,000 of souls, there will be about 164 inhabitants to each square mile.

5. SWEDEN is 1,150 miles in length, and about 600 in breadth.

6. NORWAY—An ancient province of Denmark, was lately ceded to Sweden; Sweden has been stated to contain 45,730 English square miles. The population is estimated at three millions, to which we must add 700,000 souls in Norway.

7. The Danish Dominions.— The Kingdom of Denmark consists of Zealand, Holstein, Lunenburgh, Jutland, Iceland, and the Feroe Islands. It formerly extended from the river Elbe to the northern extremity of Lapland, being about 1,400 miles in length, exclusive of the entrance into the Baltic; its breadth may be taken at 150. Of this great length, Denmark occupies about 260 miles, the rest belongs to Norway.

8. Russia.—This empire, the largest in extent, and the most powerful in the world, extends from the Baltic and Sweden on the west, to Kamschatka and the Eastern Ocean, and from the Arctic Sea on the north to the boundaries of Turkey, the Euxine and Caspian Seas, Eastern and Western Tartary and other unknown regions of Asia, on the south. It is about 9,200 miles in length, and 2,400 in breadth.

Observation. The population of European Russia was formerly estimated at thirty-three millions, and that of Asiatic Russia at three millions; but its entire population is now nearly 50,000,000, part of whom are mere barbarians.

9. France is 600 miles in length from north to south; and 560 in breadth from east to west. It was formerly divided into provinces; but since the revolution, it has been divided into departments.

Observation. The Islands belonging to France are the

isles of Hieres, near Toulon, which are the same as Homer's Isle of Calypso; the isles of Rhe, Belleisle, and Oleron, near Rochelle, are in the Bay of Biscay. Corsica boasts itself the birth-place of Napoleon.

10. HOLLAND; OR THE KINGDOM OF THE LOW COUNTRIES. The seven united provinces usually called Holland, from the principal of them, are about 150 miles in length, by about 100 in breadth.

Observation. The united provinces are, properly speaking eight, but the two last forming only one sovereignty, they are generally called the seven united provinces.

11. SWITZERLAND.—Bounded on the east by the Tyrol and Austrian Swabia, on the west by France, on the north by the Black Forest and a part of Swabia, and on the south by Savoy and Italy, is about 200 miles from east to west, and 130 from north to south; but as remarkable for its mountains, as for the poverty and simplicity of its inhabitants; a great part of it consists of nothing but vast rocks, partly covered with perpetual ice and snow.

12. GERMANY.—Subdivided into a number of independent states, which are all united by a political confederation, called the *Germanic Confederation*, extends about 600 miles in length from the isle of Rugen in the north, to the

southern limits of Austria; the breadth, from the Rhine to the eastern boundary of Silesia is about 500 miles.

It is divided into nine great parts called circles.

Three northern	*Three in the middle*	*Three southern*
Westphalia	Lower Rhine	Swabia
Lower Saxony	Upper Rhine	Bavaria
Upper Saxony	Franconia	Austria.

These circles are subdivided into principalities, duchies, electorates, bishopricks, &c. The number of independent princes is about 200.

13. Prussia.—Exclusive of small detached territories this kingdom is about 600 miles in length by 300 in breadth.

Observation. The population of the whole of the Prussian territories amounts to little more than 9,000,000 of souls.

14. Spain.—The greatest extent of Spain from west to east is 600 miles, and its breadth from north to south 500 miles.

Observation. The population of Spain is estimated at 11,000,000.

15. Portugal.—The most westerly kingdom of Europe is about 360 miles in length, by 120 in breadth. It is divided into six provinces.

Observation. The population is estimated at something less than 3,000,000.

16. Italy, the garden of Europe extends from north to south 670 miles; and the medial breadth from the Adriatic shores to those of the

Mediterranean is about 100 miles: in the northern part, the breadth is 200 miles.

17. TURKEY in Europe, includes ancient Greece, and extends about 870 miles in length, from the northern boundary of Moldavia to Cape Matapan in the Morea. The breadth, from the western extremity to Constantinople, is reckoned 680 miles.

Observation. The population of Turkey in Europe has been estimated at 8,000,000; but this number is probably too great.

The islands of Candia, Cyprus, Rhodes, Egripo, Lemnos, Samos, Mitylene, Naxia, and other islands in the Archipelago, belong to Turkey.

18. THE REPUBLIC OF THE SEVEN ISLANDS, South-west of Greece, consists of Corfu, Cephalonia, Zante, Cerigo, Lucidia, and others; these confederated islands at present enjoy an independent government, under the protection of Great Britain.

Questions for Examination.

1. How are the British Islands situated?

2, 3, 4. How are England, Scotland and Ireland respectively situated, by what bounded, and what is the superficial content of each?

5, 6, 7, 8. How are Sweden, Norway, the Danish Dominions, and Russia situated? what is the extent of each? and what the population of European Russia?

9, 10, 11. What is the extent of France, Holland, and Switzerland?

12, 13. What are the extent and divisions of Germany; the extent and population of Prussia?

14, 15, 16. What are the extent and population of Spain, Portugal and Italy?

17, 18. Detail the particulars recorded of Turkey, its islands; and the republic of the Seven Islands.

III. Asia.

1. Is bounded on the north by the Arctic Ocean, on the east by the Pacific Ocean, on the south by the Indian Ocean, and on the west by the Red Sea, the Mediterranean, the Black Sea, and Europe.

Observation. Its length reckoned from west to east may be estimated at 5,000 British miles, and its breadth, from the southern cape of Malacca to the cape of Cevero Vastochnoi in the Arctic Ocean, at 5,250 miles.

2. Asia contains the following States.

In the north.

Countries.	*Chief towns.*
Siberia or Russian Tartary	Astracan on the river Wolga. Tobolsk on the river Irtish.

In the middle.

The Chinese Empire	China	Pekin
	Chinese Tartary	Cashgar
	Tibet	Lassa
Independent Tartary		Samarcand, river Sogda.
Turkey in Asia		Aleppo and Jerusalem.

In the south.

Countries.	*Chief towns.*
Arabia	Mecca and Medina.
Persia	Ispahan and Shirez.
Hindostan	Delhi and Calcutta.
The Birman Empire	Ummerapoora and Ava.
Malaya or Malacca	Malacca.

3. The inhabitants of SIBERIA cannot amount at present to more than 3,500,000. The trade is chiefly in furs and skins.

4. The population of CHINA has been estimated at 333,000,000. The chief export is tea, of which, it is said 13,000,000 lbs. weight are consumed by great Britain and her dependencies, and 5,000,000 by the rest of Europe. China has rich mines of all the precious metals It produces abundance of corn, rice, fruit and cotton.

5. INDEPENDENT TARTARY consists of Great Bucharia, Little Bucharia, the country of the Kirgauses, and that of the Usbeck Tartars.

Observation. The climate of TURKEY IN ASIA is delightful; but this country suffers much from the plague. It produces cotton, silk, oil, fruits, wines and rhubarb, and is famous for carpets.

6. ARABIA is divided into three parts: Arabia Stony, Arabia Desert, and Arabia Happy. Suez, Mocha and Aden, on the Red Sea, are sea-ports in Arabia. Camels are the common beasts of burden.

7. PERSIA is a very mountainous country, and contains several deserts. From Persia are brought silks, carpets, leather, and gold and silver lace.

Observation. The population of the parts of HINDOSTAN subject to Great Britain amounts to 14,000,000. India produces rice, sugar, cotton, calicoes, silk, indigo, salt-petre, diamonds, &c.

8. **The Birman Empire** is in the eastern peninsula of India, and extends over Laos and Cambodia. There are numerous and large forests in this empire; the teek tree is superior to the English oak. Cambodia is celebrated for the camboge gum.

9. **Malacca** occupies the southern part of the eastern peninsula of India. The Malay language is reckoned the finest in all the Indies, where it is as common as the French is in Europe.

10. Seas, Bays, and Gulfs.

The following seas belong to this quarter of the globe:

1. The Arabian Gulf or Red Sea, between Africa and Arabia; its length from Babelmandel to Suez is 1,470 miles.
2. The Persian Gulf, between Arabia and Persia, about half the length of the former, and which receives those celebrated rivers Euphrates and Tigris.
3. The Bay of Bengal, separating the two peninsulas of India.
4. The Gulf of Siam, to the South of Siam.
5. The Gulf of Tungquin, to the south of China.
6. The Yellow Sea, to the east of China.
7. The Sea of Japan, and
8. The Sea of Okhotsk.

Observation. Asia may lay claim to the Levant, the Archipelago, the Sea of Marmora, the Black Sea and the Sea of Azof, already enumerated among the Seas of Europe.

11. Asia contains one remarkable sea, to wit, the Caspian, whose length is 700 miles, and breadth from 100 to 200. To the east of this is the sea of Aral, in length 200 miles, and about 70 in breadth. Another remarkable detached sea is that of Baikal, being about 850 miles in length, and 35 in breadth.

12. Straits.

1. The Strait of Babelmandel, at the entrance of the Red Sea.

2. The Strait of Malacca, betweèn Malacca and Sumatra.

3. The Strait of Sunda, between Sumatra and Java.

4. The Strait of Corea, between Corea and the Japanese islands, and

5. Bherring's Strait between Asia and America.

13. The Asiatic Mountains, are,

1. The Ouralian, between Europe and Asia, in length more than 1000 miles.

2. The Altaian chain extends across the centre of Asia, or about 5000 miles.

3. The mountains of Tibet, constituting the Hymalayan chain, are the highest on the globe; the highest peak covered with eternal snow, above the plains of Gonakh' pûr, is upon the lowest computation 26,862 feet above the level of the ocean.

4. Mount Taurus was by the ancients supposed to extend from Cape Chilidoni in Asia Minor through Armenia even to India. The Caucasian mountains lie between the Black Sea and the Caspian.

5. Towards the east of Armenia is Mount Ararat, whose highest summit is covered with perpetual snow.

6. In Syria, the most celebrated mountain is that of Lebanon, running in the northerly and southerly direction of the Mediterranean; the highest parts are between Balbec and Damascus.

7. Mount Olympus, of classic fame, is near the city of Bursa, in Asia Minor, and is one of the highest in Asia.

8. The eastern and western Gauts are in Hindostan.

14. Rivers.

1. The Obi; 2. The Enissei; 3. The Lena; 4. The Amour; 5. The Hoanho; 6. The Kian-ku; 7. The Burrampoot; 8. The Ganges; 9. The Indus.

15. Of the Asiatic Isles.

The island of Ceylon, now in the possession of the English, lies to the south of the western peninsula of

India. The Nicobar and Andaman isles are in the Bay of Bengal at some distance from the coast of Malacca. The small island of Bombay, an English settlement, and a place of great strength, is on the Coromandel coast.

To the north-east of Asia are the Japanese Isles, the largest of which is Niphon, in length 750 miles, and in breadth 80. Jesso or Chicha lies to the north.

The Eastern Archipelago.

16. In the Eastern Archipelago are the Sunda Isles, the Bornean Isles, the Manillas or Philippine Islands, the Celebezian Isles, the Spice Islands including the Moluccas.

Austral Asia

17. Contains the following islands, New Holland, Papua or New Guinea, and the Papuan Isles, New Britain and New Ireland, with the Solomon Isles, New Caledonia and the New Hebrides, New Zealand, Van Diemen's Land, separated from New Holland by Bass's Strait, which is about 30 leagues wide.

Polynesia.

18. The groups of islands in the Pacific Ocean have been styled *Polynesia,* and consist of the following islands:

1. The Pelew islands.
2. The Ladrone, or Marian islands, the principal of which are Guam and Tinian.
3. The Carolines, the largest of which are the Hogolen and Yap.

4. The Sandwich islands discovered by Captain Cook. Owhyhee, where that enterprising navigator lost his life, is the largest, being about 100 miles in length.

5. The Marquesas, which are very numerous.

6. The Society islands; above 60 in number: Otaheite is the largest.

7. The Friendly islands, and the Fejei islands.

8. The Navigator's islands, the principal of which are Otutuelah, Tumaluah, &c.

Questions for Examination.

1. How is Asia situated? and what are its length and breadth?

2. What states, with their capitals, does it contain in the north, the middle, and the south?

3, 4. What is the population of Siberia and China, and what the chief export of the latter?

5, 6, 7. What is said of Independent Tartary; the climate and produce of Turkey in Asia; of Arabia and Persia, with the population and produce of Hindostan?

8, 9. What of the Birman Empire and Malacca?

10. What are the seas, bays and gulfs of Asia?

11. What of the Caspian Sea and the Sea of Aral?

12. What are the Asiatic straits?

13, 14. Describe the chief Asiatic mountains and rivers.

15. And also the Asiatic isles.

16. Of what is the Eastern Archipelago composed?

17. What islands does Austral Asia contain?

18. What also are the groups of isles composing Polynesia?

IV. Africa.

1. Africa is bounded on the north by the Mediterranean Sea, on the east by the Red Sea

and the Indian Ocean, on the south by the Southern Ocean, and on the west by the Atlantic Ocean. Its length is about 4,900 miles, and breadth about 4,800 miles. It is the third continent in size, and is joined to Asia, by the Isthmus of Suez.

2. *Division.*

Countries.	*Capitals.*
Abyssinia	Gondar
Egypt	Cairo

MAHOMETAN STATES IN THE NORTH.

Tripoli	Tripoli
Tunis	Tunis
Algiers	Algiers
Morocco	Morocco

Observation. The inhabitants of these states are chiefly remarkable for their piracies.

3. *African Islands.*

1. Madagascar, on the east, is one of the largest islands in the world, except New Holland, being 980 miles in length, and 260 in breadth.

2. The smaller islands are the Mauritius, or the isle of France, and Bourbon, or Re-union : they are now (1819) in the possession of Great Britain.

3. Kirguelen's Land, far to the south, was called by Captain Cook, the *Island of Desolation.*

4. The islands in the Atlantic Ocean are St. Helena, Ascension Island, St. Thomas, St. Matthew, Cape Verd Isles, ten in number, the two largest are St. Jago and St. Anthony, the Canary Isles, on one of which is the Peak

of Teneriffe, said to be visible at the distance of 80 leagues, and which is more than $2\frac{1}{2}$ miles high; Madeira Island is remarkable for its wines.

Questions for Examination.

1. How is Africa situated, by what bounded, and what are its greatest length and breadth?
2. Into what countries is Africa divided?
3. What are the African islands?

V. America.

1. This continent, which is called the Western Hemisphere or New World, is bounded on the North by the *Arctic Ocean*, on the east by the Atlantic Ocean, on the south by the Antarctic Ocean, and on the west by the Pacific Ocean. It is separated from Asia, by Bherring's Strait.

The length of America, estimating it from 72 degrees of north latitude to Magalhaen's strait, is about 8,800 miles, and its greatest breadth about 4,400 miles.

This continent is divided into two parts, called North and South America; these are united by the Isthmus of Darien, or Panama, narrower than that of Suez.

North America.

2. North America includes the British possessions, the United States, the Spanish Dominions, and the Native Tribes.

The American, or West-India Islands.

3. In the order of their importance, are:

1. Cuba, which belongs to Spain, its length about 700, and its breadth about 70 miles.

2. St Domingo, now in possession of the Blacks, in length 400, and in breadth 100 miles.

3. Jamaica, the most valuable of the English West India Islands, and

4. Porto Rico, which belongs to Spain.

5. The Caribbee Islands extend from Tobago in the south, to the Virgin Isles in the north. Of these by the treaty of 1814, Barbadoes, Antigua, St. Christopher's, St. Vincent, Dominica, Grenada, Trinidad, Montserat, Nevis, and the Virgin Isles, are British.

Obs. All the French West India Islands were taken by the English during the late war, but we have given up

6. Martinique, Guadaloupe, St. Lucie, and Tobago, to France; the Danes possess St. Croix, St. Thomas, and St. John; the Swedes hold St. Bartholomew, and the Dutch, Eustatius.

7. The Bahama or Lucayos Islands, to the north of St. Domingo and Cuba, belong to the English; the principal is Providence Island.

8. The Bermudas, or Summer Islands, situated half-way between Nova-Scotia and the West Indies, belong to the English.

Obs. From the West-India Islands are procured sugar, rum, cotton, indigo, cocoa, coffee, and mahogany.

South America.

4. The length of South America, from Cape Vela to Cape Horn, may be estimated at 4,700 miles, and its breadth from Cape Blanco on the west, to Cape Roque on the east, at 3,200 miles.

5. *Division.*

South America may be divided into

1. The Spanish Possessions. 2. Portuguese Dominions. 3. French Dominions. 4. Dutch Territories. 5. Native Tribes.

Obs. (1.) South America is best known for its gold and silver mines. The choicest gums and drugs are likewise found in various parts of this continent. The southern part, Patagonia, is extremely desolate and barren.

(2.) A terrible struggle for liberty has existed for some years back in South America; the political divisions of this fine country cannot therefore be said to be perfect.

6. *The Islands belonging to South America, are*

1. The islands of Juan Fernandes, and Chilac in the Pacific Ocean.

2. Terra del Fuego, separated from the continent by the strait of Magalhaen.

3. Falkland's Islands to the east of this strait, and

4. Trinidad on the north, already named among the West India Islands.

Questions for Examination.

1. By what is America bounded; what is its extent; into what is it divided?

2. What does North America include?

3. What are the North American Isles, and what their respective sizes?

4. What are the length and breadth of South America?

5. Into what different possessions is it divided; and for what is South America famous?

6. What are the South American Islands?

ASTRONOMY.

Plate 1. *to face page 83.*

The Solar System.

1 ☿ *Mercury* 2 ♀ *Venus* 3 ♁ *Earth & Moon* 4 ♂ *Mars* 5 *Piazzi or Ceres*
6 ♃ *Jupiter & his 4 Moons* 7 ♄ *Saturn & his 7 Moons* 8 ♅ *Herschel & his 6 Moons.*
Each of the two elliptical Curves represents the Orbit of a Comet.

Engraved for Pinnock & Maunders Elements of Science & Art by Sid^y Hall.

CHAPTER VII.

Of Astronomy.

Section I.

The Solar System.

1. Astronomy is the science that teaches the motions of the planets and other heavenly bodies, and that explains the phenomena occasioned by those motions.

2. By observation of the stars at night, we discover in some of them the four following circumstances, first, that they never twinkle as the others do; secondly, that they are earlier seen in the evening and later in the morning; thirdly, that they change their places with regard to the others and to one another; fourthly, that they move in the same line, or nearly so, with the moon, among the other orbs of night: these bodies are called Planets, and are distinguished, in the manner we have described, from the others, which are called Fixed Stars.

3. By the assistance of telescopes we find that some of these planets have smaller bodies revolving around them; these smaller bodies are called Secondary Planets, Moons, or Satellites.

Illustration. This globe which we inhabit is called a Planet, because, as shall hereafter be shown, it partakes of a similar shape and motion with the other planets; and the Moon is called a Secondary Planet, because it revolves round the earth as its centre of motion.

4. The solar system consists of the sun (☉) in the centre, about which the earth and other planets revolve;

Of seven primary planets, Mercury ☿, Venus ♀, the Earth ⊖, Mars ♂, Jupiter ♃, Saturn ♄, Uranus or Herschel ♅;

Of four Asteroids, or minor planets, viz. Ceres, Pallas, Juno, and Vesta; Of eighteen secondary planets, viz. the Earth's moon, Jupiter's four satellites, Saturn's seven moons, and six belonging to Herschel. There belong also to this system a considerable number of comets.

5. THE SUN is a spherical body, situated near the centre of gravity of the system of planets of which our Earth is one; its diameter is 877,547 English miles; and it revolves round its axis 25 days and 10 hours.

The sun is supposed to be a most magnificent habitable globe, surrounded by a double set of clouds, whose upper stratum, of a phosphoric nature, forms the luminous apparen globe we behold.

The sun is about a 100,000 times bigger than the earth, yet it appears small on account of its distance, which is so great, that a cannon ball would be twenty-five years coming from thence to the earth, even if it flew as swift as it does, when it is first discharged from the mouth of a cannon.

6. MERCURY is the nearest planet to the sun, and goes round him in about eighty-seven days and twenty-three hours, or a little less than three months; which is the length of his year.

The length of the days and nights of this planet are nearly the same as those of our earth. His distance from the sun is computed at thirty-six millions of miles, his diameter three thousand one hundred and twenty; and in his course round the sun, he moves at the rate of a hundred and five thousand miles an hour.

7. VENUS is the next planet above Mercury, and she is computed to be sixty-eight millions of miles from the sun, and moving seventy-six thousand miles an hour, she completes her annual revolution in 224 days and 16 hours, that is to say, in about seven months and a half. Her diameter is seven thousand seven hundred miles, and her diurnal rotation on her axis, is performed in 23 hours and 21 minutes.

Venus is often seen in broad day-light.

When Venus is to the west of the sun, she rises before the sun, and is called a morning star; this appearance continues about 290 days together; when this planet is to the east of the sun, she sets after the sun, and is called an evening star for about the same period of 290 days. Venus, the brightest of the planets, has a considerable atmosphere, and some astronomers assert that they have seen mountains on its surface.

Questions for Examination.

1. What is astronomy?
2. How do we discover the planets from the fixed stars?

3. What are satellites?
4. Of what bodies is the solar system composed?
5. Give the particulars of the sun.
6. What is related of the planet Mercury?
7. Give the particulars of the planet Venus.

SECTION II.

Of the Earth.

1. The earth is the next primary planet in the solar system. The earth is of a globular form.

Observation. This is proved, 1st, Because the shadow of the earth projected on the moon in an eclipse is always circular. 2dly, The convexity of the surface of the sea is visible, the mast of a ship approaching the land being seen before her hull. 3dly, In proportion as we travel northward the north polar star becomes more elevated. 4thly, Navigators, by steering their course continually westward, arrive again at the place from whence they departed.

Definitions.

1. The *Axis* of the earth is an imaginary line passing through its centre, upon which it is supposed to turn, and about which all the heavenly bodies appear to have a diurnal revolution.

2. The *Poles* of the earth are the extremities of this axis. The celestial poles are two imaginary points in the heavens, exactly above the terrestrial poles. The one is the north, and the other the south pole.

3. The circles, supposed to be drawn about the earth, are divided into two classes; viz. *great* and *small* circles.

4. The *great circles* are these: the equator, which passes round the centre of the earth perpendicular to its axis, and at an equal distance from either pole. The equator divides the earth into two equal hemispheres. The equator is divided into 360 equal parts, called degrees; and by them we measure the longitudes of places.

5. The *ecliptic*, in which the sun makes his apparent annual progress among the fixed stars, is another great circle inclined to the plane of the equator in an angle of 23° 28′ nearly.

6. The other great circles of the sphere are called *meridians*, which completely envelope the globe, intersecting the equator at right angles. These meridians are called lines of longitude; and they are divided into 360 equal parts, called degrees; and by the meridians we measure the latitude of places.

7. The *zodiac* is a space which extends about 8° on each side of the ecliptic, like a belt or girdle, within which the motions of all the planets are performed.

8. *Signs of the zodiac.* The ecliptic and zodiac are divided into twelve equal parts, called signs, each containing 30°; and the sun makes his apparent annual progress through the ecliptic at the rate of nearly a degree in a day.

9. The names of the signs, and the days on which the sun enters them, are as follows:

Spring signs.

♈ Aries, the *Ram*, 21st of March.
♉ Taurus, the *Bull*, 19th of April.
♊ Gemini, the *Twins*, 20th of May.

Summer signs.

♋ Cancer, the *Crab*, 21st of June.
♌ Leo, the *Lion*, 22nd of July.
♍ Virgo, the *Virgin*, 22nd of August.

All *northward* of the equator.

Autumnal signs.

♎ Libra, the *Balance*, 23rd of September.
♏ Scorpio, the *Scorpion*, 23rd of October.
♐ Sagittarius, the *Archer*, 22nd of November.

Winter signs.

♑ Capricornus, the *Goat*, 21st of December.
♒ Aquarius, the *Water-bearer*, 20th of January.
♓ Pisces, the *Fishes*, 19th of February.

These are called *southern* signs, being all south of the equator.

It is not easy to say, why the ancient astronomers affixed such images as the Ram, the Bull, &c. to the twelve signs of the Zodiac. There is great reason, however, to suppose that they were placed as hieroglyphics of the seasons of the year, alluding to the annual course of the sun. Thus Aries, Taurus and Gemini, represent March, April, and May, the spring quarter of the year, when lambs, calves and goats, (the latter generally bring forth twin kids) are produced.

Cancer, the Crab, which creeps both ways, represents the increase and decrease of the sun's declination, to and from the summer solstice, in June.

Leo, the Lion, intimates the raging heat of the sun in July, which the ancients compared to the furious nature of that fierce animal.

Virgo, the Virgin, with a spike or ear of corn in her hand, properly represents August, when the harvest of the earth is ripe.

Libra, the Balance, is displayed in September, to intimate that the days, at the autumnal equinox, are equal in all parts of the globe.

Scorpio, the Scorpion, a noxious animal, is placed as

the hieroglyphic of October, because, at that season, diseases of various kinds too often rage.

Sagittarius, the Archer, marks November as the proper time for hunting.

Capricornus, the Goat, by its climbing up the rocks, is an emblem of December, when the sun, at the winter solstice, begins to ascend again towards the equinoctial.

Aquarius, the Water-bearer, with his urn, represents January, when rains are frequent.

Pisces is emblematical of the fishing season, which began in the Nile in the month of February.

10. The *sensible horizon* is an imaginary circle which appears to touch the surface of the earth, and to separate the visible part of the heavens from the invisible, and extends only a few miles.

11. The *rational horizon* is a circle parallel to the former, the plane of which passes through the centre of the earth, and cuts the heavens into two equal hemispheres.

12. The *poles of the horizon* are two points, the one of which, over the head of the spectator, is called the *Zenith*, and the other, which is under his feet, is called the *Nadir*.

13. *Parallels* of latitude are lesser circles of the sphere parallel to the equator.

14. The *latitude* of a place upon the surface of the earth, is its distance from the equator, measured in degrees, and is either north or south. Latitude extends 90° North or South.

15. The *longitude* of any place on the surface of the earth is its distance from the meridian of Greenwich or any other meridian used by convention, as *Zero*, or the *first* meridian. Longitude extends 180° east or west.

The two points in which the ecliptic cuts the equator, are called the *equinoctial* points. The vernal equinox is at the first degree of Aries in the ecliptic; the autumnal at the first of Libra.

The points of the ecliptic which are at the greatest

distance from the equator are called the *solstices;* and the circles which pass though these points parallel to the equator are called the tropics of *Capricorn* and *Cancer*. *Capricorn* is the name of the southern Tropic; *Cancer*, that of the northern.

The whole earth is divided into 5 zones, viz. 1 *torrid* lying between the tropics; 2 *temperate* zones extending from the tropics to *the polar* circles; 2 frigid zones between the polar circles and poles.

2. The *magnitude* of the *earth.* The earth is 360 degrees in circumference, every degree contains $69\frac{1}{2}$ English miles. Now $360\times 69\frac{1}{2}=$ 25,020 English miles, the circumference of the earth; its diameter is 7,964 miles, for $25{,}020 \div 3.1416 = 7964$ nearly. The Earth is above 95 millions of miles distant from the sun.

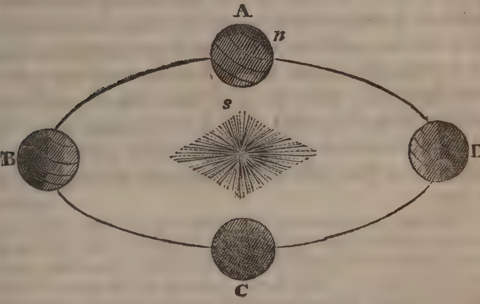
Note. 3.1416 is our divisor when we want to find the diameter of a circle whose circumference is given.

Of the motion of the Earth producing the Seasons, and the succession of Day and Night.

3. The revolution of the earth round its axis, every twenty four hours, is called its diurnal motion. This motion alternately causes day and night, as either side is turned towards or from the sun. The periodical revolution of the earth round the sun, in three hundred and sixty-five days six hours, is called its annual motion, which produces the four seasons of the year.

To form a conception of these two motions of the earth, let us take the ball A for the earth

moving round the ellipse which in this diagram may also represent the orbit of the earth. Now the ball proceeds forward in the ellipse, not by



sliding along like a plane upon wood, or a slate upon ice, but by turning round its own axis *n s*, which is an imaginary line passing through the centre of the earth A. This then being the point of motion we can easily trace the revolution of the earth in its orbit, and have a very accurate notion of its diurnal revolution also.

2. Conceiving the matter then in this way, and that the earth, in the space of twenty-four hours, moves from west to east, the inhabitants on the surface of it, like men on the deck of a ship, who are insensible of their own motion, and think that the shores move from them in a contrary direction, will conceive that the sun and stars move from east to west, in the same time of twenty-four hours, in which they, along with the earth, move from west to east.

4. This daily or diurnal motion of the earth being once clearly understood, we may easily form a notion of its annual or yearly motion round the sun. For as that luminary seems to have a daily motion round our earth, but which motion is really occasioned by the daily revolution of the earth round its axis, so, in the course of a year, he seems to have an annual motion in the heavens, and to rise and set in different points of them; but this is only occasioned by the daily motion of the earth in its orbit or path round the sun, which it completes in the time of a year.

This double motion of the earth may also be compared to a coach turning round in a court-yard. The wheels go round their own axis, at the same time that they move round the yard. The earth travels at the rate of fifty-eight thousand miles every hour, which is one hundred and twenty times swifter than a cannon ball; and by its rapid motion on its axis, the inhabitants of London are carried five hundred and eighty miles every hour. Those at the equator move much faster; those towards the poles much slower; and those at the very poles hardly move at all.

What has been said, with regard to the motion of the earth, the smallest reflection may lead us to apply to the other planets.

5. If we take the position A as the spring season, when the days and nights are all equal, the sun being at that time vertical to the equatorial parts of the earth;

The position B is the summer season, when the sun being vertical to the tropical parts of

the earth, the inhabitants of the north pole enjoy summer, those of the south pole winter.

The position C is the autumnal season, when the *terminator* or ellipse passing through the poles, the days and nights are equal.

The position D is the winter season of the inhabitants of the northern hemisphere.

The positions B and D are solsticial points; A and C equinoctial points: and in the summer when the earth is at B it is farther from the sun than in the winter when the earth is at D, though in the diagram this distance is not regarded.

Of the Moon.

6. The *Moon*, our earth's satellite, is a globe of about 2000 miles diameter, and distant from the earth about one quarter of a million of miles. The moon performs her periodical revolution round the earth in about 27 days.

Observation. (1.) The moon borrows all her light from the sun; and when we view her with the naked eye we discern a number of spots, which we are taught by astronomers to consider seas, continents, mountains, &c.; and on a more accurate inspection, with a telescope, the hypothesis of planetary worlds receives additional confirmation. Vast cavities and heights are observed upon various parts of her surface, exactly resembling vallies and mountains; and every other appearance seems to indicate, that she is a body of the same nature with our earth; and Herschel is said to have discovered a manifest volcano in the moon.

(2.) One of the most remarkable phenomena attending the moon, is the continual change of figure to which she is subject. Sometimes she appears perfectly full, or circular, at other times half, at other times only a quarter illuminated, changing through a great variety of shapes: and these changes prove that she receives her light from the sun, for the moon being enlightened on that side only which faces the sun, a greater or less quantity of that enlightened part will be visible, according as it is turned towards us, or from us; and her figure will consequently appear to vary through the whole of her revolution. This may be easily illustrated by means of an ivory ball, which being held before a candle in various positions, will present a greater or less portion of its illuminated hemisphere to the view of the observer, according to its situation.

Of the Tides.

7. That regular motion of the sea, according to which it ebbs and flows twice in twenty-four hours, is called its tides.

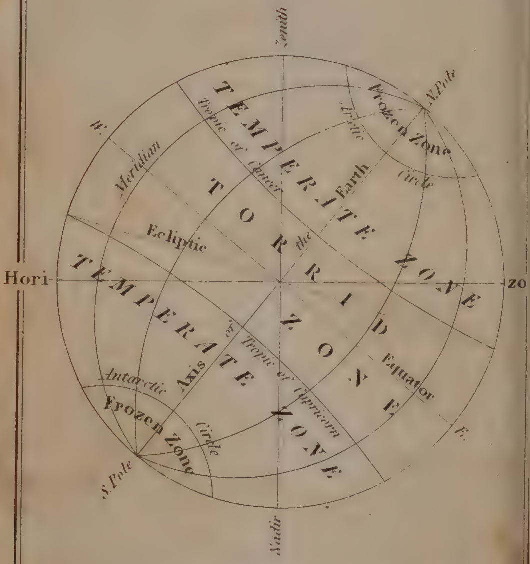
Observation. (1.) In its flux, the sea generally rises for about six hours, when it remains, as it were, suspended, in equilibrio, for some minutes. It is then high water.

(2.) In its reflux, the sea falls for about six hours, when it remains, in like manner, suspended, in equilibrio, for some minutes. It is then called low water.

(3.) The tides are occasioned by the attraction of the moon; which Newton has explained by the principle of gravity or attraction.

(4.) The tides are greatest at the new and full moons, and are then called *spring tides.* They are least at the first and last quadratures, and are then called neap tides. The highest tides are about the times of the equinoxes in spring and autumn.

ASTRONOMY.



Projection of the chief lines on the Sphere.

Engraved for Pinnock & Maunders Elements of Science & Art by Sid.ʸ Hall.

to face page 95.

Relative Sizes of the Planets.

Engraved for Pinnock & Maunders Elements of Science & Art by Sid^y Hall.

Questions for Examination.

1. How is the earth proved to be a round or spherical body ?*
2. What is the magnitude of the earth ?
3. Define the diurnal and annual motions of the earth.
4. Explain both these motions from a diagram.
5. Shew how the seasons are produced, and from a diagram what is the position of the earth at each season.
6. Give the particulars of the moon.
7. Give the particulars of the tides.

SECTION III.

The superior Planets. †

1. MARS, the planet first above the earth's orbit, is distant from the sun 142,000,000 miles. He moves at the rate of 55,000 miles an hour, and completes his revolution round the earth in a little less than 4 of our years. The

* Each of the definitions respecting the earth the pupil should commit to memory.

† Called superior because their orbits are without that of the earth; in this respect they are superior or above it.

diameter of Mars is 4390 miles; the diurnal rotation 24 hours 39 minutes.

Mars never shines with a bright light, but has a red appearance, whence it is concluded it has a dense atmosphere.

2. VESTA. The next planet in our system is Vesta, for the knowledge of which we are indebted to Dr. Olbers of Bremen, who first discovered it on the 29th March, 1807. The distance of this planet from the sun is about two hundred and twenty-three millions of miles; its annual revolution in its orbit is performed in about 3 years $7\frac{1}{4}$ months. But its diameter, and the duration of its diurnal rotation, have not been yet ascertained.

3. JUNO, the next in order, is another new planet, which was discovered by Mr. Harding, at the observatory at Lilienthal, near Bremen, September 1st, 1804. The mean distance of this planet from the sun is accounted two hundred and fifty-three millions of miles. Its annual revolution is performed in 4 years, 4 months, and 6 days; but its diameter is unknown as yet; as is also the time of its revolving on its axis.

4. PALLAS. The next superior planet above Juno is Pallas, which was first discovered by Dr. Olbers, March 28th, 1802. The mean distance of this planet from the sun, is reckoned two hundred and sixty-three millions of miles. Its revolution in its orbit is performed in about 4 years, 7 months, and 10 days; but like the two former,

its diameter and diurnal rotation have not yet been ascertained.

5. CERES is the next higher planet in our system; which was first discovered by Piazzi of Palermo, January 1st, 1801. Its mean distance is nearly the same as that of Pallas, being estimated, in round numbers, at 263 millions of miles; and consequently its annual revolution is also nearly the same, being performed in 4 years 7 months and 11 days.

Observation. The extreme minuteness of these planets, their being so recently discovered, and their great distance from us, render the results of philosophers' observations upon them in some measure uncertain. We have, however, reason to conclude, that the diameter of none of them exceeds 400 miles, or is less than 100 miles. But astronomers have not yet made an accurate estimate of their diurnal rotation.

6. JUPITER is the largest of all the planets, and is reckoned to be about four hundred and eighty-five millions of miles from the sun; and by going at the rate of twenty-nine thousand miles an hour, he completes his annual revolution in something less than twelve of our years. His diameter is computed to be ninety-one thousand five hundred miles; and, by a prodigiously rapid motion upon his axis, he performs his diurnal rotation in 9 hours and 55 minutes.

7. SATURN, the next planet in the system, above Jupiter, is about eight hundred and ninety millions of miles from the sun; and by moving at the rate of twenty-two thousand miles an

hour, he performs his annual circuit round that luminary in something less than 29½ of our years. His diameter is computed to be about seventy-six thousand miles; but, on account of his immense distance, and the deficiency of light occasioned by such a remote situation, the time of his diurnal rotation upon his axis was for a long time unknown. It is now however ascertained to be about 10 hours 16 minutes.

8. URANUS or Herschel. The next or highest planet in our system, at present known, is Uranus or the Georgium Sidus; which was first discovered by Dr. Herschel, March 13th, 1781.

Observation. The elements of this planet have been now accurately determined; from which it appears, that its mean distance from the sun is about one thousand eight hundred millions of miles, and its diameter thirty-five thousand. Its annual revolution is performed in about 84 years; but the time of its revolving on its axis has not been discovered by observation; although, from analogy, Laplace conceives that it must be performed in about the same time, or rather less, than that of Saturn.

OF THE CAUSES OF THE PLANETARY MOTIONS.

9. According to the demonstrations of Newton, the planets are retained in their orbits by gravitation, which draws or impels them towards the centre of motion; and they are carried forward by a projectile force, which tends to whirl them

off at right angles to the other force, or in a tangent to their orbit.

Observation. (1.) The power which produces this projectile motion forwards in a straight line, is called the centrifugal force; while the power which occasions gravitation towards the sun, is termed the centripetal force.

(2.) The motion of the earth being well understood, that of the other primary planets may soon be comprehended.

Questions for Examination.

1. Give the particulars of Mars.

2, 3. What are the particulars related of Vesta and of Juno?

4, 5. Give the facts recorded of Pallas and of Ceres.

6, 7, 8. Also those of Jupiter, Saturn, Uranus or Herschel.

9. What is the cause of the planetary motions?

SECTION IV.

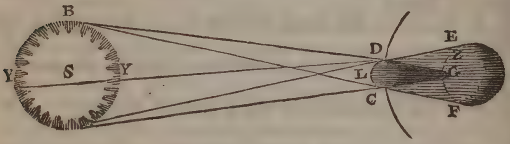
Of Eclipses.

1. When any one of the heavenly bodies is obscured or darkened by the shadow of another falling upon it, or by the interposition of any body, it is said to be *eclipsed*. And an *eclipse* is

a *total* or a *partial* privation of the light of the moon or the sun.

2. The eclipses of the sun and moon are the most striking. And an eclipse of the sun happens when the moon, passing between the sun and the earth, intercepts the sun's light, and the sun can only be eclipsed at the new moon, or when the moon, at its conjunction, is in or near one of its nodes.

Illustration. Thus, let S be the sun, C D the moon, and E F the earth, the moon revolving round the sun with the earth, intercepts the sun's rays B D, &c., and throws



upon the earth E F a conical shadow D G C, which deprives the people of that part of the earth of the sun's light; and hence because they could not see the sun they say it is eclipsed.

3. In a total eclipse of the sun, the shadow of the moon falls upon that part of the earth where the eclipse is seen, as at G.

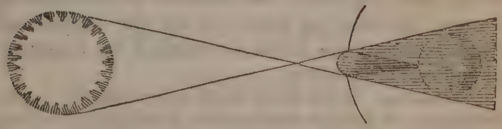
A spectator, placed any where in the centre, will not see any part of the sun, because the moon will intercept all the rays of light which come to him directly from the sun; and it is manifest that, in this situation, the moon

being an opaque body, will cast its shade upon the part of the earth where the eclipse is total.

4. In a partial eclipse of the sun, a penumbra, or imperfect shadow of the moon, falls upon that part of the earth where the partial eclipse is seen. If the moon, when new, is in one of its nodes, the eclipse of the sun will be *central;* for then the centres of the earth, sun, and moon, being all in the plane of the ecliptic, the centre of the moon will pass between the sun's centre and that of the earth.

5. An eclipse of the sun is said to be annular, when at the time of the eclipse a ring of the sun appears round the edges of the moon; and a central eclipse of the sun will be an annular one, if the distance of the moon from the earth at the time of the eclipse be greater than its mean distance.

Were the orbit of the earth and that of the moon, both in the same plane, an eclipse of the sun would happen at every new moon, and an eclipse of the moon at

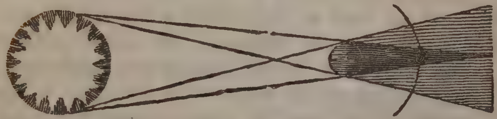


every full moon. But the orbit of the moon makes an angle of about five degrees and a quarter, with the plane of the orbit of the earth, and crosses it in two points called nodes. An eclipse of the sun begins on the western

side of his disk, and ends on the eastern; and an eclip se of the moon begins on the eastern side of her disk, and ends on the western.

The average number of eclipses in a year is four, two of the sun and two of the moon; and as the sun and moon are as long below the horizon of any particular place as they are above it, the average number of eclipses in a year are two, one of the sun and one of the moon.

6. An *eclipse of the moon* happens when it falls within the shadow of the earth as in the subjoined figure. And in the same manner in



which we here behold the moon of our earth eclipsed, the satellites of Jupiter are also eclipsed, and the observation of these eclipses assists mariners to find their longitude. The sun being larger than the earth, the shadow of the earth is a cone, the base of which is on the surface of the earth, and the moon is eclipsed by a section of the earth's shadow.

Observation. If the earth were larger than or equal to the sun, its shadow would either perpetually enlarge, or be always of the same dimension; but in this case the superior planets would sometimes come within it, and be eclipsed, which never happens. Therefore, the sun is larger than the earth, and produces a shadow from the

earth of a conical form, the apex of which does not extend to the orbit of Mars.

7. An eclipse of the Moon is partial, when only a part of its disk is within the shadow of the earth; it is total, when all its disk is within the shadow; and it is central, when the centre of the earth's shadow falls upon the centre of the moon's disk.

Questions for Examination.

1, 2. What is an eclipse? What eclipses are the most striking? Explain how an eclipse of the sun happens.

3, 4. Describe the circumstances attending a total and a partial eclipse of the sun.

5. Also those attending an annular eclipse, and explain why we have not an eclipse of the sun every new moon, and an eclipse of the moon every full moon.

6. Detail the particulars attending an eclipse of the moon.

7. Define partial, total and central eclipses of the moon.

SECTION V.

Celestial Phenomena.

1. *Of Comets.*

1. Comets are opaque bodies, like the planets, and move round the sun, but in very eccentric orbits. It is thence concluded that their cold must be excessive when at the extremity of their

orbits from the sun; but their heat must be so intense when near him as would destroy, or at least vitrify, our earth.

Comets are always attended with long transparent trains or tails, issuing from that side of them, which is turned away from the sun.

Sir Isaac Newton computed the heat of the comet that appeared in the year 1680, when nearest the sun, to be two thousand times hotter than red hot iron, and that being thus heated, it must retain its heat till it comes round again, although its period should be more than twenty thousand years; it is computed to be only five hundred and seventy-five. There are supposed to be at least twenty-one comets belonging to our system, moving in different directions. All those which have been observed, have moved through the etherial regions and the orbits of the planets, without suffering the least sensible resistance in their motions, which sufficiently proves that the planets move in free space. Of all the comets, the periods of three only are known with any degree of certainty, being found to return at intervals of 75, 129, and 576 years: and of these, that which appeared in 1680 is the most remarkable. This comet, at its greatest distance, is about eleven thousand two hundred millions of miles from the sun, and its least distance from that luminary four hundred and ninety thousand miles. In that part of its orbit which is nearest the sun, it flies at the rate of eight hundred and eighty thousand miles in an hour; the sun, as seen from it, will appear one hundred degrees in breadth, and consequently forty thousand times as large as he appears to us. The tail of this comet was at least an 100 millions of miles long; and that of 1811 was 30 millions of miles.

2. *Of the Fixed Stars.*

2. The fixed stars comprehend all the other heavenly bodies except the sun, planets and comets. These stars are known easily by being less brilliant and luminous than the planets, and by continually exhibiting that appearance which we call the twinkling of the stars. And they are called fixed from the remarkable circumstance of their never changing their situation, with regard to each other, as the planets change their places.

Modern discoveries make it probable, that each of these fixed stars is a sun, the centre of a system of worlds revolving round it, as our sun has the earth and other planets revolving round him. On this principle, how magnificent does astronomy appear, presenting as many systems of worlds perhaps as there are fixed stars in the expanse of heaven.

Sirius, the dog-star, appears twenty-seven thousand times less than the sun; and, as the distance of the stars must be greater as they seem less; mathematicians have computed the distance of Sirius from us to be two billions and two hundred thousand millions of miles.

3. *Of the Constellations on each side of the Zodiac.*

The first people who paid much attention to the fixed stars were the shepherds in the beautiful plains of Egypt and Babylon. Endowed with a lively fancy they divided the stars into different companies or constellations, each of which they supposed to represent the image of some animal, or other terrestrial object.

Observation. The peasants in our country do the same thing; for they distinguish that great northern constellation, which philosophers call Ursa Major, by the name of the Plough, the figure it may certainly represent with a very little help from the fancy.

But the constellations, in general, have preserved the names, which were given them by the ancients. They are reckoned twenty-one northern, and twelve southern; but the moderns have increased the number of the northern to thirty-six and of the southern to thirty.

Northern Constellations.

The Little Bear, the Great Bear, the Dragon; the Greyhound, Bootes, and Mons Menelaus: Cephœus, Berenice's Hair, Charles's Heart, the Northern Crown, Hercules and Cerberus: The Harp, the Swan, the Fox, the Goose, the Lizard, Cassiopeia, and Perseus: Andromeda, theGreat Triangle, the Little Triangle, Auriga, Pegasus, the Dolphin, and the Arrow: The Eagle, Serpentarius, the Serpent, Sobieski's Shield, Cameleopardus, and the Colt: Antinous, the Lynx, the Little Lion, and Musca.

Southern Constellations.

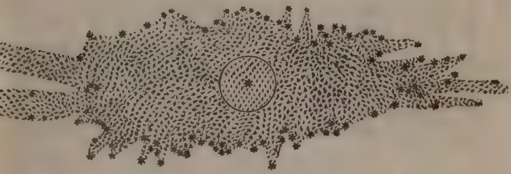
The Whale, the River Eridanus, the Hare, Orion, the Great Dog, and the Little Dog: The Ship, Argo, Hydra, the Centaur, the Cup, the Crow, the Wolf, and the Altar: the Southern Crown, the Southern Fish, the Phœnix, the Crane and the Peacock: Noah's Dove, the Indian, the Bird of Paradise, Charles's Oak, the Southern Triangle, and the Fly or Bee: the Swallow, the Cameleon, the Flying Fish, the American Goose, the Water Serpent, and the Sword Fish.

Observation. Some of the principal stars have particular names given them, as Aldebaran in the Bull's Eye; Regulus or the Lion's Heart; Arcturus in Bootes; Sirius in the Great Dog; Spica or the Ear of Corn, in Virgo: Pleiades, or the Seven Stars.

4. *Of the Galaxy or Milky Way.*

Besides the stars visible to the naked eye, iere is a very remarkable space in the heavens, alled the Galaxy or Milky Way. This is a road circle of a whitish hue, like milk, going uite round the whole heavens, and consisting of n infinite number of small stars, visible through telescope, though not discernible by the naked ye.

5. The annexed diagram represents a portion of the ilky way, or ecliptic of the fixed stars. The small rcle is supposed to be fifteen minutes in diameter nd in a circle of this magnitude, Dr. Herschel counted ne time 588 stars and at another time 600; and this iscovery was verified by Cassini.



Of Twilight.

6. We are indebted chiefly for the phenonenon of twilight to the light reflected by our tmosphere. When the sun is a certain distance elow the horizon he shines on some part of the

air immediately visible to us, which affords us a portion of reflected light.

The distance at which this may happen has been variously estimated, and it is perhaps different in different climates, being a little greater in countries near the poles, than in those near the equator.

Some have assigned 18° as the limit of the twilight, and on this supposition the atmosphere must be capable of reflecting sensible light at the height of about 40 miles. M. Lambert makes the limit of twilight only about $6\frac{1}{2}$°.

The duration of twilight is greater or less as the sun moves more or less obliquely with respect to the horizon: it is therefore, shortest near the times of the equinoxes, since the equinoctial intersects the horizon less obliquely than any less circle parallel to it.

Questions for Examination.

1. Relate what is recorded of comets.
2. What is said of the fixed stars?
3. What is the origin of the names of the constellations? Repeat those of the northern, also those of the southern hemisphere.
4. What is said of the galaxy or milky way?
5. What is the cause of twilight?

CHAPTER VIII.

Navigation.

1. Navigation is that art which instructs the mariner in what manner he may conduct a ship through the trackless ocean, from one port to another, with the greatest safety, and in the shortest time possible.

Obs. (1.) The origin of navigation, like that of all other arts and sciences of ancient date, is lost in obscurity. At first men little removed from the savage state, would pass rivers on rafts or logs of wood, to exchange their commodities, or search for the means of subsistence. They would also traverse the sea coasts, and reach adjacent islands, in canoes scooped out of the trunks of trees, and rowed along by oars or paddles. In process of time, as arts and sciences advanced, men would design vessels of large capacity and stout make, to navigate boisterous seas, and resist the impetuosity of the waves. The action of the winds, the effects of which are so sensible, would soon suggest the use of sails.

(2.) The confusion and uncertainty in which the first navigators must have found themselves, when, either prompted by their enterprising spirit to visit remote parts, or driven by the force of storms out of the sight of land, would naturally induce them to study some method of finding where they were in such circumstances. They might soon be sensible that the inspection of the heavenly bodies, was the only means that could afford them just conclusions in this respect; and in this manner, probably, astronomy came to be applied to navigation.

(3.) The Phœnicians, particularly those of Tyre, are now generally considered as the first people who made

any great advances in this important art. These were afterwards followed up by the Carthaginians, who discovered the *Fortunate Islands*, or the Canaries.

(4.) From Carthage and Tyre, commerce and navigation were transferred principally to Alexandria, which latter city when under the Romans, was only inferior to Rome itself, the latter being supplied with its merchandize wholly from the former.

(5.) Constantinople became afterwards the centre of commerce, and navigation was for a long time pursued with great ardour by the merchants of that city. After this it began gradually to spread itself, though slowly, amongst the several European cities and nations. Geneva and Venice, are particularly distinguished for the active part they took in promoting this important branch of human knowledge.

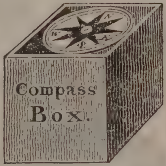
(6.) But the present art of navigation owed its rise to the invention of the *mariner's compass*, in the beginning of the 14th century. This important nautical instrument had its origin in the discovery of the natural *magnet* or *loadstone*, which has the wonderful property of turning to the pole, when suspended and left at liberty to move freely.

Upon this principle depend the construction and use of the mariner's compass, an instrument which enables the mariner to conduct his vessel, in any given direction, through vast oceans out of the sight of land.

2. The natural loadstone has the quality of communicating its properties to iron and steel; which, when properly prepared, are touched, or rubbed, by the loadstone, and they are then called artificial magnets.

3. An artificial magnet fitted up in a proper box, for the purpose of guiding the direction of a traveller, is called a magnetic needle, and the whole together is called the mariner's compass, of which the annexed diagrams afford a good view.

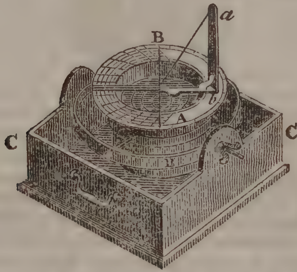
Illus. (1.) The mariner's compass consists of three parts; the box, the card or fly, and the needle. The box contains the card with the needle, and is made of a circular form, either of wood, or copper. It is suspended within a square wooden box, by two concentric brass circles called gimbalds, which are so fixed by cross axes to the two boxes, that the inner one, or compass box, retains a horizontal position in all motions of the ship. The compass box is covered with a pane of glass, that the movements of the card may not be disturbed by the wind.



This card is a circular piece of paper, fastened upon the needle, and moves with it. Sometimes there is a slender rim of brass, fastened to the extremities of the needle, to keep the card stretched. The outer edge of this card is divided into 360 degrees, and within the circle of these divisions it is again divided into 32 equal parts, called the points of the compass, or rhumbs. Each of these is again subdivided into quarters. The initial letters N, W, S, E, are annexed to those rhumbs, to denote the North, West, South and East. The middle part of the card is painted with a star, whose rays terminate in the divisions just enumerated.

Compass Card.

4. The azimuth compass is nothing more than the above-mentioned compass, of which C C is the box, and to this compass, two sights, of which *a* is one, are adapted, through which the sun is to be seen, in order to find its azimuth, and from thence to ascertain the declination of the magnetic needle at the place of observation: in one of these is an oblong aperture, with a perpendicular thread or wire stretched through its middle, and in the other sight there is a narrow perpendicular slit.



The ring of the gimbalds rests with its pivots on a semicircle A B, the foot of which turns in a socket; so that whilst the box is kept steady, the compass may be turned round, in order to place the sights in the direction of the sun.

There are, on the outside of the box, two lines perpendicularly along the sides: these lines serve to show how many degrees the north or south

pole of the needle is distant from the azimuth of the sun.

5. Navigation may be divided into two branches:

I. SEAMANSHIP, comprehending the method of managing a vessel by disposing her sails, rudder, &c., so that she may move in any assigned course or direction which the wind and weather will permit; and

II. NAVIGATION *proper*, which comprehends those methods by which a mariner determines at any time the situation of his vessel, the course she is to be steered, and the distance she has to run, to gain her intended port.

6. Hence the requisites for a mariner, in order to understand this branch of the nautical art, are

1. A competent knowledge of the figure and magnitude of the earth, with the various imaginary circles drawn upon it, so as to be able to ascertain the distance and situation of places with respect to each other.

2. The method of finding the ship's latitude and longitude, either by her course and distance run, or by astronomical instruments.

3. The use of various instruments, as the log, compass, half-minute glass, quadrant, sextant, &c.

4. The different allowances necessary to be made in estimating a ship's way, as for lee way, variation, and currents.

5. The method of finding the time of high water at any place.

6. The use of charts both plane and Mercator's, with the method of constructing them: all of which principles depend upon mathematics and astronomy.

Questions for Examination.

1. What is navigation? Describe its progress, 1st, among the first men: 2ndly, as it received aid from astronomy: 3dly, among the Phœnicians: 4thly, among the Carthaginians: 5thly, among the Europeans: and 6thly, the accession it gained in the 14th century.

2. Describe accurately the natural *magnet* or *load-stone.*

3. What are artificial magnets? How is a mariner's compass made? and what are its properties when fitted up properly?

4. What is the construction of the azimuth compass?

5. Into what two branches is navigation divided?

6. What are the six requisites mentioned for a mariner, in order to understand the nautical art practically?

CHAPTER IX.

Grammar.

1. *Definition.* Grammar is the art of speaking or of writing any language with propriety; and the purpose of language is to communicate our thoughts.

2. Grammar considered as an art, necessarily supposes the previous existence of language; and as its design is to teach any language to those who are ignorant of it, it must be adapted to the genius of that particular language of which it treats.

Observation. A just method of grammar, therefore, without attempting any alterations in a language already introduced, furnishes certain observations called *rules*, to which the methods of speaking used in that language may be reduced; and this collection of rules is called *the grammar* of that particular language.

3. Grammar then is either particular, or it is universal.

I. For the greater distinction with regard to these rules, Grammarians have usually divided this subject into four distinct heads: viz.

1. Orthography, or *the art of combining letters into syllables, and syllables into words.*

2. Etymology, or *the art of deducing one word from another, and the various modifications by which the sense of any one word can be diversified, consistently with its original meaning, or its relation to the theme whence it is derived.*

3. SYNTAX, or what relates to *the construction or due disposition of the words of a language, into sentences or phrases.*

4. PROSODY, or that which treats of *the quantities and accents of syllables, and the art of making verses.*

4. II. But grammar, considered as a *science*, views language only as it is significant of *thought*. Neglecting particular and arbitrary modifications introduced for the sake of beauty or elegance, it examines the analogy and relation between words and ideas ; distinguishes between those particulars which are essential to language, and those which are only accidental; and thus furnishes a certain standard, by which different languages may be compared, and their several excellencies or defects pointed out. This is what is called *philosophic* or *universal* grammar.

Observation. The design of speech is to communicate to others the thoughts and perceptions of the speaker's mind. Language is, therefore, the express image and picture of human thoughts, and from the picture we may often draw certain conclusions with regard to the original.

5. Language consists of words significant of ideas; and these words may be arranged into four general divisions called SUBSTANTIVES, ATTRIBUTIVES, DEFINITIVES and CONNECTIVES.

We shall in this brief grammar confine ourselves to the different kinds of words significant of our ideas.

Questions for Examination.

1. Define grammar.
2. How is grammar considered as an art, and what is the grammar of a particular language?
3. Into what heads have Grammarians divided its rules; and what are orthography, etymology, syntax and prosody, respectively?
4. Describe the object of grammar, considered as a *science;* and also the design of speech.
5. Into what four general divisions have words been divided.

1. Of Substantives.

1. Substantives are all those words which are expressive of things that exist, or are conceived to exist of themselves, and not as the energies or qualities of any thing else. These may be divided into two orders: viz.

I. Nouns, properly so called, being the names of all those things which exist, or are conceived to exist. These may be divided into three kinds, each of which admits of the following subdivisions:

(2.) 1. Natural, or those which are used as the names of natural substances; such are 1. *animal*, 2. *man*, *dog*, 3. *Alexander*, *Cerberus:* where the genus, species, and individual are indicated, by the successive numerals, 1, 2, 3.

(3.) 2. Artificial, or the several names of artificial objects, such as, 1. *edifice*, 2. *house*, *church*, 3. *the Vatican*, *St. Paul's*, &c.

(4.) 3. Abstract, or those which are the names of qualities considered as abstracted from their substances,

such as, 1. *motion*, 2. *flight*, *course*, 3. *the falcon's flight, the grey-hound's course*, &c.

5. *Nouns* of all kinds admit the following accidents, viz. *gender*, *number*, *cases*.

(6.) 1. *Gender*, the distinction of nouns, with regard to sex, takes three subdivisions, into the *masculine*, the *feminine*, and the *neuter*.

The masculine gender, denotes animals of the male kind; as, a man, a horse, a bull.

The feminine gender, signifies animals of the female kind; as, a woman, a duck, a hen.

The neuter gender, denotes objects that are neither male nor female; as, a field, a house, a garden.

(7.) 2. Number is the consideration of an object as alone, or united to other objects of the same kind, or of different kinds.

There are two numbers the singular and plural; as, when we say a chair, chairs, a tree, trees, &c. where the word *chair*, or *tree* indicates one of the kind; but the word *chairs*, or *trees*, more than one.

(8.) 3. Cases are those changes the noun undergoes in its ending in the learned languages, that from expressing a general, it may express a particular idea. In the Greek language there are five, in the Latin six, and in the English three of those cases.

Thus we have a *nominative*, a *possessive*, and an *objective* case; as a *mother*, *mother's*, *mother*.

(9.) II. PRONOUNS are a species of word invented to supply the place of nouns in certain circumstances. They are of two kinds.

(10.) 1. PREPOSITIVE; so called, because they are capable of leading a sentence. These are divided into three orders, called the pronouns of the *first person*, or I; of the *second person*, or THOU; of the *third person*, or HE, SHE, IT: and

(11.) 2. SUBJUNCTIVE; so called, because it cannot lead a sentence, but only serves to subjoin a clause to another which was previous; of this kind are *which*, *who*, *what*, &c.

Questions for Examination.

1. Define what substantives are. Into what divisions have nouns, properly so called, been divided?

2. Define and illustrate natural nouns.

3. Also artificial nouns.

4. In like manner abstract nouns.

5, 6. Of those accidents which nouns admit, what is gender? And what are the masculine, feminine and neuter genders?

7. What is number, and how many numbers do nouns have?

8. What are cases, and how many have we in the English language?

9. What are pronouns?

10, 11. And what prepositive, and subjunctive pronouns?

2. OF ATTRIBUTIVES.

1. ATTRIBUTIVES are those words that are expressive of all such things as are conceived to exist, not of themselves, but as the attributes of other things. These are divided into *verbs*, *participles*, *adjectives* and *adverbs*.

2. VERBS are those words which are expressive

of an attribute and an assertion; as, *I write;* and they all admit of the variations after mentioned.

3. The *attributes* expressed by verbs have their essence in *motion* or its *privation;* and as *motion* is always accompanied by *time,* VERBS are, therefore, liable to certain variations, called

TENSES.

1. The PRESENT, which represents the action going on, and as contemporary with something else, as, *I write,* or *I am writing,* just *now.*

2. The IMPERFECT, which represents the action or event, either as past and finished, or as remaining unfinished at a certain time past, as, *I was writing,* or *I wrote;* —no matter when, yesterday, last week, or last year.

3. The PERFECT tense, which not only refers to what is past, but also conveys an allusion to the present time; as, *I have written* on substantives *this morning; I have written* some chapters of the Elements this month.

4. The PLUPERFECT tense, which represents a thing not only as past, but also as prior to some other point of time specified in the sentence; as, *I had written* last week *before* I saw you.

5. The FIRST FUTURE tense, which represents the action of the verb to be going on at some indefinite future time; as, *I shall write,* or *be writing,* to-morrow, next week, &c.

6. The SECOND FUTURE, which represents the action of the verb to be going on at some definite future time; as, *I shall have written when you come* to-morrow, next week, &c.

4. AFFIRMATION is the essence of the verb: insomuch that *all verbs* may be resolved into the substantive verb IS, and another *attributive.* But we may affirm something of the ACTION of the

verb *directly*; something of our LIBERTY or CAPACITY to *perform* that action; or something of our WISH that *another person* should perform it. To denote these several kinds of affirmation, all verbs have what Grammarians call

MODES; *viz.*

1st. The INDICATIVE, to denote the *first* kind of affirmation; as, *I write.*

2dly. The SUBJUNCTIVE, to denote the *second*; as *I may* or *can write.*

3dly. The IMPERATIVE to denote the *third*; as *write thou*, or *do thou write.*

4thly. The POTENTIAL, to denote possibility, or liberty, power, will or obligation; as, *it may rain; I may read* or *listen* to another; *you can study; they should learn.*

5thly. The INFINITIVE, to express a thing in a general and unlimited manner, without any distinction of number or person; as *to write, to walk*, &c.

5. Verbs have likewise been distinguished into the following kinds according to the nature of the *attribute* of which they are expressive:

1st. ACTIVE TRANSITIVE, or those which denote an action that *passes from the agent to some external object*; as, Cæsar *conquered* Pompey.

2dly. ACTIVE INTRANSITIVE, or those which express that kind of action which has *no effect* upon *any thing beyond the agent himself*; as Cæsar *walked.*

3dly. PASSIVE, or those which express *not* action, but *passion*, whether pleasing or painful; as Portia *was loved;* Pompey *was conquered.*

4thly. NEUTER, or those which express an attribute that consists neither in *action* nor in *passion*; as Cæsar *stood.*

6. PARTICIPLES are those words expressive of an attribute combined with time; as the PRESENT *writing*, which expresses the action of the verb *to write*, as going on; the PAST *written*, which expresses the action of the same verb as *finished*, and therefore *time past*.

7. ADJECTIVES are those words which express, as *inhering in their substances*, the several qualities of things, of which the essence consists not in motion or its privation. Hence an adjective is defined to be word added to a substantive to express its quality; as, an *industrious* boy; a *virtuous* woman; a *benevolent* mind.

But as there may be various degrees of quality; adjectives are subjected to these three degrees.

1*st*. The *positive*, which expresses the quality of the thing; as, *green*, *good*, *little*, &c.

2*dly*. The *comparative*, which increases or lessens the quality, as, *greener*, *better*, *less*, &c.

3*dly*. The *superlative*, which exalts to its highest pitch, or depresses to its lowest, the quality of the substance or thing; as, *greenest*, *best*, *least*, &c.

8. ADVERBS are those words which denote the *attributes of attributes*. Hence they are called attributes of the *second order*, to distinguish them from verbs, participles and adjectives, which, as we have seen, denote the attributes of substantives, and are, therefore, called ATTRIBUTIVES of the *first order*.

9. ADVERBS are divided into two kinds:

1*st*. Those that are common to all attributives of the first order; that is, which coalesce equally

with verbs, with participles, and with adjectives. These may be divided into adverbs

Of *intension* and *remission*, or of *quantity continuous*; as, *moderately*, *vastly*, *exceedingly*; and these, like adjectives of a similar nature, admit of the different *degrees of comparison.*

Of *quantity discrete*, as, *once*, *twice*, *thrice*, &c. Though these are more properly possessive cases of *one*, *two*, *three*, &c. Of *relation*; as, *more*, *most*, *less*, *equally*, &c.

2dly. Those that are confined to verbs properly so called, and which are of the following kinds.

Of *time*; as, *then*, *when*, *afterwards*, *now*, &c.

Of *place*; as, *here*, *there*, *where*, *hence*, &c.

Of *intensions* and *remissions* peculiar to motion as, *speedily*, *hastily*, *slowly*, &c.

Questions for Examination.

1. Define what are attributives?
2. Define what verbs are?
3. In what have the attributes expressed by verbs their essence? And you are required to define the tenses of verbs.
4. What is the foundation of modes, and how many modes are there? Define each.
5. Define now verbs active transitive, intransitive, passive and neuter.
6. Define now the participles.
7. What are adjectives, and of how many degrees?
8. What are adverbs, and what their use?
9. Illustrate the two kinds into which they have been divided; as belonging to attributives of the first order; or to verbs, properly so called.

3. *Of Definitives and Connectives.*

1. DEFINITIVES are those words that serve to *define* and *ascertain* any particular object or objects as *separated* from others of the same class. These are commonly called articles, which are divided into two kinds: *viz.*

1*st.* The *indefinite;* as, *a* or *an*, *any*, *some;* and
2*dly.* The *definite;* as, *the*, *this*, *that*.

Observation. These two articles *this*, *that*, have as plurals *these* and *those*.

2. CONNECTIVES are those words which are employed to *connect* other words, and, of several distinct parts to make one complete whole. They may be divided into two kinds; *viz.*

(3.) I. CONJUNCTIONS; by which name are distinguished all those connectives which are commonly employed to conjoin words and sentences. These have been divided into two kinds called, *first*, *Conjunctions copulative;* as, *and*, *if*, *since*, *because*, *therefore*, &c.; and, *secondly*, *Conjunctions disjunctive;* as, *but*, *or*, *nor*, *as*, *than*, *though*, &c.: and

(4.) II. PREPOSITIONS, or those connectives whose common office is to conjoin words which refuse to coalesce; and this they can do only by signifying those relations by which the things expressed by the united words are connected in nature; as, "He went *from* London to York," where the preposition *from* literally denotes the relation subsisting between his going from London to York; or, "She is *above* disguise," where the preposition *above* is used metaphorically to denote her superiority.

5. Interjections, common to all languages,

express the passions or emotions of the soul; as *ah! O! Oh me! alas!*

Questions for Examination.

1. What are definitives, and their uses?
2. What are connectives, and their uses?
3. What are conjunctions, and their uses?
4. What are prepositions, and their uses?
5. What are interjections?

4. Syntax.

Of Sentences.

1. A sentence is an assemblage of words forming a complete sense. The principal members of a sentence are, the subject, the attribute, and the object.

The *subject* is the thing chiefly spoken of; the *attribute* is the thing or action affirmed or denied of it; and the *object* is the thing affected by such action; as *Alexander pursued Darius. Alexander* is the subject; *pursued* the attribute; and *Darius* the object.

2. Syntax consists of two parts, concord and government.

1. *Concord* is the agreement of one word with another; as the man *who*, the horse *which.*
2. *Government* is the power one part of speech has over another in directing its mode, tense, or case; as *the man whom I respect; the horse which I rode yesterday.*

CHAPTER X.

Rhetoric.

1. Rhetoric is the art of speaking with propriety. The principal end of rhetoric is to *instruct*, to *persuade*, and to *please*.

Rhetoric is divided into four parts, namely, *invention*, *disposition*, *elocution*, and *pronunciation*.

2. *Invention* implies the discovering of such arguments or reasons, as are suited, according to the nature of the subject, to instruct, to persuade, or to gain the assent and belief of our hearers to that subject. Arguments drawn from reason are to inform the judgment, or to instruct; arguments drawn from the affections, are to move the passions, or to please.

3. *Disposition* is the ranging our arguments in the most orderly and proper manner according to the rules of logic.

The parts of an oration are usually reckoned *six:* namely,

1. Exordium.	4. Confirmation.
2. Narration.	5. Refutation, and
3. Proposition.	6. Peroration.

4. In the *exordium*, or beginning of an oration, the orator gives his audience some intimation of his subject, and prepares their mind for attention.

In this part he must be clear, modest, and not too prolix, for obscurity at the commencement of a discourse, never fails to excite in the hearers a suspicion of the speaker's dulness and ignorance; ostentation in the orator begets the self-love and pride of the hearers against him; and prolixity in a discourse so much resembles a great portico before a small building, that we judge meanly of what is to attract us after we have entered.

5. The *narration* is a brief recital of the whole case, from beginning to end.

This ought to be plain and perspicuous, that it may be understood; likely or probable, that it may be believed; pleasing, that it may be willingly listened to; and short, that it may not tire the audience.

6. The *proposition* proposes the sum of the whole discourse.

If it divides the oration into parts, which ought never to exceed three, or four at most, these are called *partitions*. The beauty of the *partition* or division is, that it be full, distinct, plain, short, and certain.

7. The *confirmation* is the strengthening and confirming our cause, by all the proofs and arguments we can obtain from invention.

In doing this the orator places his strongest arguments in the front, when the minds of his hearers are fired with the greatest expectation. His weakest arguments he employs in the middle, where their number may render them of seeming importance. But he makes a reserve of some of the most forcible reasons to bring up the *rear*, because what the audience hear *last* makes the greatest impression upon their minds.

8. In the *refutation*, or confutation, the orator answers all his adversary's arguments, and

takes off all objections, by showing them to be absurd, false, or inconsistent.

9. The *peroration* or conclusion, recapitulates or sums up the strongest and the principal arguments, and endeavours to gain the assent of the hearers by moving the passions. In a conclusion, an orator, should always observe brevity and vehemence.

10. Besides the parts just mentioned, there is frequently room for *digression, transition,* and *amplification.*

Digression, in dry discussions, is useful to relieve the mind. But it must not be too long, nor introduced too frequently.

Transitions are forms in speech, used to remind the hearer, in few words, what has already been said, or what is intended to be said.

By *amplification* the orator expatiates on a subject in such a manner as to represent it in its full force, to convince the understanding and influence the passions.

11. OF ELOCUTION. The parts of elocution are *elegance, composition,* and *dignity.*

Illus. I. ELEGANCE consists in the purity, perspicuity, and politeness of language. It is chiefly acquired by reading the best and most correct authors, conversing with gentlemen and scholars, and by study and practice.

II. COMPOSITION regards grammatical plainness and propriety, by imitating the phrase, idiom, and order of words, made use of by the best authors, in the several sorts of style, whether in the humble, the middle, or the sublime, or whether the subject be philosophical, historical, or poetical.

III. DIGNITY is that which adorns language with sublime thoughts and rhetorical flowers, such as noble

tropes, moving figures, and beautiful turns or repetitions.

12. Figures or Tropes. A *trope* is the elegant turning of a word, from its natural and proper to a relative signification. It is derived from the Greek word *trepo*, I turn.

The chief tropes in language are, *metaphor*; *allegory*; *metonomy*; *irony*; *synecdoche*; *hyperbole*; *climax*; *antithesis*; *prosopopeia*; and *apostrophe*.

I. A *metaphor* is a comparison, without any words implying comparison.

Example. To say a man is "like a lion," is a simile: but to say "he is a lion," is a metaphor; hence Christ is called "a vine," "a door," &c.

II. An *allegory* is a continued chain of metaphors in the same sentence or discourse, when one thing is said and another meant.

Example. Thus the Jews are represented in the Scriptures under the allegory of a vine planted, watered, and cultivated by the hand of God, which, instead of producing good fruit, brings forth sour grapes. Psalm LXXX.

Observation. Of all the figures of speech none comes so near to painting as metaphor; and when we cannot form a correct picture upon a metaphor, it is said to be *mixed* or incorrect.

III. *Metonomy* changes the names of things that are naturally though not essentially united, as the cause for the effect: thus *Mars* is put for war, and *Bacchus* for wine.

IV. *Irony* is a trope in which one thing is said and the contrary intended; as, to say of a rogue

"he is a *very very* honest man." The manner of the speaker gives force to this trope.

V. *Synecdoche* is a trope in which a part is taken for the whole.

Example. "The roof" for "the house," "the sail" for "the ship." We say ten sail of the line, meaning ten ships. Another kind of synecdoche is, when the matter of which the thing is made is used for the thing itself, as "steel" for "a sword," &c.

VI. *Hyperbole* is a trope which exceeds the bounds of strict truth, and represents things as either greater or less than they really are; it is thence the boldest of all tropes; thus of Fame it is said,

"Her head reach'd heav'n as on earth she stood."

VII. When every principal expresssion in a period adds strength to that preceeding it, the period is then *Climax.*

Example. Thus it is said of the joys of heaven, "that eye hath not seen, nor ear heard, neither hath it entered into the heart of man to conceive." We hear of more things than we see; but the imagination can conceive of much more than falls under the cognizance of the senses.

VIII. *Antithesis,* or contrast drawn between two things, serves to set off the opposite qualities of each; a fine instance is given us in Cicero's oration against Catiline:

"On the one side stands modesty, on the other impudence; on one side fidelity, on the other deceit; here piety, there sacrilege; here continency, there lust; &c.

IX. *Prosopopeia* or personification, either introduces an absent person as speaking; or one who is dead, as if he were alive and present; or speech is attributed to an inanimate being.

Example. Thus Antony vents his passion over the body of Cæsar his slaughtered friend:

"O pardon me thou bleeding piece of earth,
That I am meek and gentle with these butchers,
Thou art the ruins of the noblest man
That ever lived in the tide of times."

X. In an *apostrophe*, the speaker breaks off from the series of his discourse, and addresses himself to some particular person, present or absent, living or dead, or even to inanimate objects: thus Dryden,

"Farewell too little, and too lately known,
Whom I began to think and call my own."

13. OF POETRY. There are two ways of writing on any subject, namely, in prose and in verse.

Illus. 1. Prose is the usual method of writing without any confinement to a certain number of syllables, or varying the words in any peculiar form, which, on the contrary, verse requires.

2. In verse the words are so ranged as that the accent naturally falls on some peculiar syllables as make harmony to the ear. This is called *metre*, that is *measure*. When two or more verses, near to each other, are made to end with the same or the like *sound*, it is called *rhyme*.

3. *Blank verse* has no rhyme, but the words are generally disposed in metre, so as that the accent may fall on every *second*, *fourth*, and *sixth* syllable; and on the *eighth*, *tenth*, and *twelfth* also, if the lines are so long.

i. *Pastoral* poetry describes a shepherd's life, or that of rural nymphs and swains.

ii. *Elegy* is a mournful poem, or funeral song.

iii. The *Pindaric* ode, so called from its inventor Pindar, is a sort of poetry which consists of loose and free numbers, and unequal measures.

iv. *Satire* is a free, jocose, witty, and sharp poem, severely inveighing against vice and all corrupt manners and persons.

v. *Comedy* is an agreeable imitation of the actions, humours, and customs of common life.

vi. *Tragedy* represents, and acts over again the calamities of illustrious men and women.

vii. The *Epic* or heroic poem, is an interesting relation of some illustrious and important actions of the hero celebrated in the poem, as the great exploits of Achilles in the Iliad of Homer, and those of Æneas in the Æneid of Virgil.

viii. The *Epigram* is an inferior sort of poem, whose peculiar character is brevity, beauty, and a sharp turn of wit at the end.

ix. The *Acrostic, Rondeau, Echo,* &c. are trifling pieces of art that poets make in a merry vein, or on some jocose occasion.

14. OF STYLE. Style is the mode of expressing our thoughts in words, and writers on rhetoric distinguish three kinds of style, which they call the *plain*, the *sublime*, and *mediate*. Now, as the business of an orator is to instruct, to please, and to move the passions, these three kinds of eloquence answer all those purposes. Thus the plain style is used to *teach*, the sublime to *move*, and the mediate to *delight*.

Illus. i. The *plain style* requires perspicuity, simplicity, and exactness; simplicity of thought, purity of diction, with an inexpressible elegance, which affects more sensibly than it seems to do, are its great ornaments. It

ejects all pomp and affectation, is very sparing in the use of tropes and figures, but requires neat and decent language, and abhors all meanness of expression.

The plain style is well adapted to narration and proof, to letters and dialogues, and indeed, to all ordinary subjects.

ii. The *sublime* style is a species of eloquence quite different from the former, being great, rich, and grand. It employs whatever is most elevated, and most capable of moving the affections, such as noble thoughts, rich expressions, bold figures, and lively passions. This sort of eloquence transports us beyond ourselves, excites our admiration and applause, and bears all before it with irresistible force. This style is adapted to all subjects that are great and uncommon, as tragedy and epic poetry.

iii. The *mediate*, called also the *intermediate*, or *equable style*, is a species of eloquence, between the plain and the sublime, having neither the simplicity of the former, nor the force and energy of the latter. It is sometimes called the *embellished*, or *florid* style, it admits of all the ornaments of art, all the beauty of figures, all the splendor of metaphors, the lustre of thoughts, the grace of digressions, the harmony of numbers and cadence. Quintilian compares it to a beautiful river, whose water is pure and clear, which flows gently, and is shaded on each side with verdant woods.

iv. The *Asiatic* style is very diffusive or prolix, abundance of words being used to express little matter. It was so called by the Greeks from the people of Asia, who affected such redundancies.

v. The *Laconic* style is quite the reverse of the former, being distinguished by its extraordinary conciseness, and by comprehending a great deal of matter under a few words. It is called *Laconic* from Laconia, a country of Peloponnesus, of which the chief city was Lacedæmon or Sparta, whose inhabitants were remarkable for writing and speaking in a pithy and concise manner.

15. The chief faults of style are, its being

tumid or *swoln*, *frigid* and *puerile*, *dry* and *jejune*.

i. The *tumid* style abounds with swelling words, which give it a seeming greatness, but within it is hollow and empty.

ii. The *frigid* or *puerile* style, affects certain trifling ornaments, insipid jests, remote and strained allusions, and redundant descriptions.

iii. The *dry*, or *jejune* style, is that which is destitute of ornament, force, and spirit.

v. A style also may be too *stiff*, or too *loose*, *fluctuating*, and *unconnected*.

16. Of Quantity, Accent, and Emphasis.—By *quantity* is meant the distinction of syllables into *long* or *short*, in reading either prose or verse. This depends on the various sounds of the vowels.

Accent is that particular stress or force of sound which the voice lays upon any syllable.

Obs. Though the accent is more frequently laid on a long syllable than a short one, it is not so always, nor is the accent always upon the same syllables in the same words. The same word when it is a verb, has the accent on the last syllable, as to convért, to rebél, to recórd; but when it is a noun, it is accented on the first, as a cónvert, a rébel, a récord.

By *emphasis* is meant a stronger and fuller sound of voice, by which we distinguish the accented syllable of some word, on which we design to lay particular stress, and show how it affects the rest of the sentence.

Obs. Sometimes the emphatic word must be distinguished by a particular tone of voice, as well as by a stronger accent. On the right management of the

emphasis, depends the whole life and spirit of every discourse. If no emphasis be placed on any words, not only is discourse rendered heavy and lifeless, but the meaning is often left ambiguous. If the emphasis be placed wrong, the meaning is wholly perverted and confounded.

17. Of Action. The gesture or action of the body should be decent, moderate, easy, various, and proper to the nature of the discourse.

Obs. 1. The speaker's body must be erect and straight, and apt for gentle flexure on either side.

2. The head should stand right upon the shoulders, the neck be free and easy of motion; the shoulders not hoisted or shrugged up, nor the arms much projected, except in the immediate affections of joy and grief.

3. The countenance, which is principally to be regarded in gesture, must be variously expressive of the passions; but always natural, and free from affected airs, grimace and contortions.

4. Great use should likewise be made of the hands, especially the right hand, which should frequently be applied to the left breast, and then let fall to the right side. By the hand, in short, we demand, call, threaten, detest, admire, and express our thoughts, almost as well as by speech itself.

5. Stamping with the *foot* is only permitted on the stage.

Questions for Examination.

1. Define *rhetoric*, and specify its subdivision.
2. Define also invention.
3. What are disposition and the six parts of a discourse?
4, 5. What of the exordium and narration?
6, 7. What also of the proposition and confirmation?

8, 9. What of the refutation and peroration?

10. Define digression, transition, and amplification.

11. Illustrate the parts of elocution, viz. *elegance, composition*, and *dignity*.

12. What are tropes or figures of speech? Now define successively,

1. A metaphor.	6. Hyperbole.
2. An allegory.	7. Climax.
3. A metonomy.	8. Antithesis.
4. Irony.	9. Prosopopeia.
5. Synecdoche.	10. Apostrophe.

13. Define prose and poetic compositions; also rhyme and blank verse; and then the different kinds of poetry.

14. Of styles, define the plain, the sublime, the mediate, &c.

15. Point out now the chief faults in style.

16. Define and illustrate quantity, accent and emphasis.

17. What is to be observed in delivery, as regards *action?*

Note. This subject is treated at large in the "Elements of Polite Literature," or the companion to the "Elements of Science and Art," published by Messrs. Pinnock and Maunder.

CHAPTER XI.

RELIGION AND MORALS.

1. Many operations in nature have been universally looked upon as the exertions of mind or spirit, distinct from man.

Observation. The perception of an end or intention in the works of men, implies the belief of an artist. The perception of end or intention in the works of nature, implies the belief in God. Hence we read in the very first sentence of the Sacred Scriptures that, "In the beginning God created the heaven and the earth."

2. The attributes of God are characters of the Supreme Being suggested by his works, and may be referred to five principal titles, UNITY, POWER, WISDOM, GOODNESS and JUSTICE.

3. Contrary to the appearances at death, the human soul has been generally supposed to survive its separation from the body, and to be reserved to a future state of rewards and punishments.

Observation 1. This apprehension is agreeable to the most rational notions of the goodness and justice of God. That that goodness which disposed the Almighty to create, may likewise dispose him for ever to preserve his intelligent creatures, is consonant to the instinctive desire of immortality which all rational beings have implanted in their soul.

2. The government of God is righteous; but man's instinctive desire of distributive justice is not fulfilled in

this life; hence the universal belief, that wicked men are to receive additional punishments, and good men additional rewards, in a future state.

3. These doctrines are however put beyond the force of human reasonings, by the specific declarations of the word of God himself in the Holy Scriptures. Therein, the immortality of the soul is announced by the voice of inspiration, and the doctrines of rewards and punishments rendered so plain that " he who runneth may read."

4. Man is born a weak, helpless, delicate creature, unprovided with food, clothing, and whatever else is necessary for subsistence and defence. The former he is incapable of supplying, against the latter he cannot secure himself.

Observation. Thus feeble and exposed he finds immediate and sure resources in the affection and care of his parents. For your parents, my dear young friend, you have contracted a fondness which you can much better feel than my pen describe; and I dare say you can recollect many instances when their absence grieved you, when on their return, or your return to them, you were charmed to see them again. Now these feelings are the foundation of *moral* attachment on your side; this domestic alliance you evince by expressions or feelings of joy, grief, hope, and fear in all that concerns your father and mother, your brothers and sisters, and other members of your family, uncles, aunts, cousins.—And as your affections now point beyond yourself, you are called a *good* or an *ill* creature, as you stand well or ill affected to them. These are the first links of the *moral chain;* the early rudiments, or outlines of your character; your first rude essays towards agency, freedom and manhood.

5. Moral actions comprise all that conduct

which the religion of the Bible, which all men, and which your own conscience, approve.

6. Conscience is evidently intended by nature to be the immediate guide and director of our conduct, after we arrive at the years of understanding.

7. Evil actions comprise all that conduct which the Bible, which all men, and which your own conscience, disapprove and condemn.

8. The virtues you are solicited, nay, commanded to practise, are *sincerity*, *charity*, *temperance*, *justice*, *prudence* and *fortitude*.

1. SINCERITY is that grand virtue which deals plainly and honestly in all actions, without disguise, without falsehood, and without hypocrisy.

Observation. Disguise, falsehood, and hypocrisy, are *vices*.

2. CHARITY is that amiable virtue, which consists in the love of God and our neighbour, and which leads us to relieve the distresses, to tolerate the imperfections, to pity the sufferings, and to ameliorate the condition of all sensitive beings.

Observation. Charity is opposed to hatred of our fellow-creatures, to persecution, cruelty, selfishness, and all barbarous treatment of the lower animals, birds, fishes, and insects; but at the same time it forbids not our using them for food.

3. TEMPERANCE is that virtue which sets bounds to our desires, ambition, and passions; it opposes our self-love, our vanity, and sensual gratifications; and by producing evenness of mind, contentment, and health, it is the foundation of long life.

Observation. Self-love appears in want of benevolence; vanity in affectation and ostentation; and sensua-

lity leads to the indulgence of vicious affections and desires, and to the commission of frauds and of crimes.

4. JUSTICE is the regard shown to the rights and happiness of mankind; and is divinely expressed in the words of our Saviour: "Do to others as ye would that they should do to you."

Observation. Justice opposes itself to tyranny, and the practice of any actions which we would not that men should do to us.

5. PRUDENCE is that discernment by which men distinguish the value of ends, and the fitness of means to obtain them. It is by prudence that men act with steadiness and consistency.

Observation. Inconsiderate people, rash youths, a heedless mob, know not this virtue; or cease to practise it when they are swayed by their passions.

6. FORTITUDE is that sublime virtue which withstands opposition, difficulty, and danger; it enables the poor to bear with adversity; the virtuous to contend against oppression; and the patriot and hero to encounter the lawless tyrant and the ferocious invader.

9. But all those virtues are referred to four capital branches: namely, *justice*, *prudence*, *temperance*, and *fortitude*.

10. The duties referred to *justice* or *probity*, are either public, or private.

11. The private duties are *innocence*, *candour*, *piety*, *friendship*, *gratitude*, *liberality*, *charity*, *civility*, and *politeness*.

i. INNOCENCE; the object of compulsory law and the most indispensable characteristic of probity implies, besides an abstinence from impurities of all kinds, veracity and faithfulness; the first opposed to deceit, the second to perfidy.

ii. PIETY is the exercise of veneration and love; first, towards God; next, towards those who by nature

or choice are proper objects of our respect and affection.

iii. FRIENDSHIP; the beneficence of private parties, proceeding from motives of particular esteem and attachment, includes the reciprocal duties of parent and child, of husband and wife, and of all other private relations.

Observation. The duties of the parent are, to maintain, to protect, to educate his child; and, as far as he is able, to establish and to secure his state or condition in life. The duties of the child are, obedience, deference, and gratitude. The duties of husband and wife are in many instances matter of strict law; but the observance of them all must proceed from the heart.

iv. GRATITUDE is the return made for favours received.

v. LIBERALITY is the free communication of what is ours to oblige others.

vi. CHARITY we have described, page 139.

vii. CIVILITY is a guarded behaviour in the ordinary intercourse of society to avoid giving offence.

viii. POLITENESS is a behaviour intended to please and oblige.

12. The *public* duties of JUSTICE or PROBITY are *allegiance* on the part of the subject; *protection* on the part of the magistrate; and *public spirit* in all parties.

i. The *allegiance* of the subject, are the fidelity, deference, and submission, he owes to the magistrate.

ii. The *protection* due from the magistrate, is the interposition of power to preserve the peace, and to secure the subject in the possession of all his rights.

iii. The *public spirit* due from every member of the community, is,

First, a faithful discharge of any office intrusted for the public good; and, *Secondly*, a continual preference of public safety and public good, to separate interests or partial considerations.

13. The duties referred to PRUDENCE are, *decency*, *propriety*, *œconomy*, *decision*, and *caution*.

Observation. It is the object of prudence, to direct a man in what he is to wish for himself, for his friend, for his country, and for mankind. In this sense, prudence is the guide or directory in every duty; but in its more limited acceptation, it refers more particularly to the duties which affect our state or condition. We have enumerated these duties already; we now proceed to explain them :—

i. DECENCY is the agreeableness of your appearance and carriage to the sense and opinion of others. The rules of decency are prohibitory, and forbid whatever would offend in nudity, filth or obscenity.

ii. PROPRIETY is the suitableness of your behaviour to your nature as a reasonable being, your age, your station in life, your rank in civilized society. There is in all the external effects of virtue, as being suitable to our nature, a propriety that may be considered apart from their other recommendations. *Diffidence*, and a cautious approach to the manners and pretensions of manhood, are proper to your youth. *Resolution* is proper to manhood; *calmness* and *deliberation* to age; *dignity* and *reserve*, without contemptuousness or petulance, are proper to men of high station; *deference* without servility, is proper to men of inferior rank.

iii. MODESTY is a proper reserve on every subject of self-estimation. It forbids ostentation of what we possess, of what we have done, or of what we may have suffered.

iv. ŒCONOMY is the proper adjustment of a person's expense to his fortune. Sensuality and gaming are adverse to good œconomy.

v. DECISION is a seasonable and resolute choice of what a person ought to do. In some cases, hesitation is equal to a total purpose of inaction; every opportunity is lost, and every measure comes too late, to the slothful and inactive.

vi. Caution consists in a proper attention to all the difficulties that may occur in what a person undertakes. The great objects of caution are, not to engage in what is above our strength, nor to commit ourselves to persons that mislead or deceive.

14. The duties referred to TEMPERANCE may be comprehended under the heads of *sobriety* and *application*.

i. Sobriety is the moderate use of food, and of other animal gratifications.

ii. Application is the preference of business to amusement. *Business* is supposed to terminate in some serious purpose, *amusement* in mere pastime.

15. The duties referred to FORTITUDE are *patience*, *intrepidity*, and *constancy*.

i. Patience is the calm and deliberate suffering of any trouble or pain that occurs in human life. *Peevishness*, the reverse of patience, tends to realize imaginary evils, and to increase what is real.

ii. Intrepidity is firmness and presence of mind, in the midst of dangers; and is frequently the greatest security against danger.

iii. Constancy is perseverance in all pursuits or engagements properly chosen. The wavering are seldom capable of executing any purpose.

Questions for Examination.

1. How do we discover in the operations of nature the existence of a Supreme Being?
2. What are the attributes of God?
3. How is the immortality of the soul proved?
4. Describe the situation of man when he first comes into this world, the foundation of moral attachment, and your notions of good and ill.
5. What are moral actions?
6. What is conscience?
7. What are evil actions?
8. Describe and illustrate the virtues of sincerity, cha-

rity, temperance, justice, prudence, and fortitude, in the order of this arrangement.

9. To what four capital branches may all these virtues be referred?

10, 11. Describe and illustrate the private duties of justice or probity, namely, innocence, candour, piety, friendship, gratitude, liberality, charity, civility, and politeness.

12. Describe and illustrate now the public duties of justice or probity, namely, allegiance, protection, and public spirit.

13. Illustrate the duties referred to prudence, namely, decency, propriety, œconomy, decision, and caution.

14. Illustrate the duties referred to temperance; namely, sobriety and application.

15. Illustrate, lastly, the duties referred to fortitude, namely, patience, intrepidity and constancy.

Popular Religions in the World.

1. The *Jewish,* professed by the descendants of Abraham, is the religion of the Old Testament.

2. The *Christian*, professed by the followers of Christ, is the religion of the New Testament and of the Old conjointly.

Observation. The early christians soon became divided into two great bodies; called the Greek church, and the Roman church.

3. The Greek church, reared since the time of the Emperor Phocas (A. D. 603.), comprehends the churches of all those countries anciently subject to the Greek or Eastern Empire, and through which their language was carried; that is, all the space extending from Greece to Mesopotamia and Per-

ia, and thence into Ægypt; and it is now spread over Russia.

4. The Roman (Latin) or Western Church comprehends all the churches of Italy, France, Spain, Africa, the North, and all other countries whither the Romans carried their language.

Observation. Great Britain, part of the Netherlands, Germany, Switzerland, Prussia, and other countries of the North, have been separated from the Latin Church ever since the time of Luther and Henry VIII.; and constitute what we call the Reformed Church, that is to say, the Protestant Believers.

5. The GALLICAN CHURCH denotes the Church of France, under the government and direction of their respective bishops and pastors.

6. The CHURCH OF ENGLAND *(Lutheran)* is Protestant, and its Book of Common Prayer unfolds its belief.

7. The CHURCH OF SCOTLAND *(Presbyterian)* is Calvinistic, or professing the doctrines of Calvin.

Observation. Lutherans are followers of Martin Luther, and Protestants; *Calvinists* take their name from John Calvin, whose tenets they profess; *Arminians* follow the doctrines of Arminius; and *Socinians* those of Socinus. *Presbyterians* deny the authority of bishops; *Independents* adhere to the principle that every church, or society of Christians, ought to regulate its own spiritual affairs, without the interference or jurisdiction of another; *Baptists* think children should not be baptised; *Quakers* look upon religious ceremonies, as the Sacraments, as no part of pure devotion; and what are called *Methodists* follow extemporaneous preachers, but use the church liturgy.

8. MAHOMETANISM, the religion of the Alcoran, established by Mahomet, styled the Impostor, who was born in the reign of *Anushirwan* the *Just*, Emperor of Persia, about the end of the 6th century of the Christian Æra.

Observation. (1.) Mahometanism is professed by the Turks, Persians, and several nations among the Africans, and many among the East Indians.

(2.) The Mahometans divide their religion into two parts, *faith* and *practice*: of which the first is divided into six distinct branches; 1, Belief in God; 2, in his angels; 3, in his scriptures; 4, in his prophets; 5, in the resurrection and final judgment; and 6, in God's absolute decrees. The points relating to practice are, prayer, with washings, &c. alms, fasting, pilgrimage to Mecca, and circumcision like the Jews.

9. The religious books of the Chinese everywhere inculcate the belief of a Supreme Being, the author and preserver of all things; but the purity of the ancient Chinese religion has been long contaminated by many idolatrous and fanatical sects.

Observation. There is reason to hope, however, that as the Holy Scriptures are now translating into the Chinese language, the pernicious and idolatrous worship of that singular people will in time fall before the Light of Heaven.

10. There is no established church in the United States of America; all religions are tolerated.

Questions for Examination.

1. What is the Jewish religion?
2. What also is the Christian?

3. What do you understand by the Greek Church?
4. What by the Roman (Latin) or Western?
5. What also by the Gallican?
6, 7. What likewise by the Church of England, and the Church of Scotland, and the various denominations of Christians called *Lutherans, Calvinists, Arminians, Socinians, Presbyterians, Independents, Baptists, Quakers* and *Methodists*?
8. What is Mahometanism?
9. What of the religion of the Chinese?
10. And of religion in America?

CHAPTER XII.

OF THE CONSTITUTION, GOVERNMENT, AND THE ADMINISTRATION OF THE LAW OF GREAT BRITAIN.

1. *Of the King and Parliament.*

1. The supreme and executive power of the British Empire is vested in a single person, King or Queen; it being indifferent to which sex the crown descends. The person entitled to this power, whether male or female, is immediately entrusted with all the ensigns, rights, and prerogatives of Royalty.

Observation. (1.) The fundamental maxim upon which the right of succession to the throne of Great Britain depends, is, "That the crown, by common law and constitutional custom, is hereditary; and this in a manner peculiar to itself: but that the right of inheritance may from time to time be changed, or limited by act of parliament." Under this limitation the crown still continues hereditary.

(2.) The King of Great Britain ranks among the greatest monarchs reigning over a free people. His person is sacred in the eye of the law, and it is high treason to imagine, or intend his death. Neither can he in himself be deemed guilty of any crime, the law taking no cognizance of his actions, except in the persons of his ministers, if they infringe the laws of the land.

(3.) The King can make war or peace, send and receive ambassadors, make treaties of league and commerce,

levy armies, and fit out fleets, for the defence of his kingdom, the annoyance of his enemies, or the suppression of rebellions; he can grant commissions to his officers, both by sea and land, or revoke them at pleasure; summon the Parliament to meet, and when met, adjourn, prorogue, or dissolve it; refuse his assent to any bill, though it has passed both houses; and by such a refusal no bill has any force.

(4.) He chooses his own council, nominates all the great officers of state, of the household, and of the church. He is the fountain of honour, whence all degrees of nobility and knighthood are derived.

2. The *Parliament* is assembled by the King's writs, and its sitting must not be intermitted above three years. The constituent parts of Parliament are, the King, sitting there in his royal political capacity, with the three estates of the realm: the Lords Spiritual, the Lords Temporal (who sit together with the King in one house), and the Commons, who sit by themselves in another.

Observation. (1.) The Lords Spiritual are the two Archbishops, and 24 Bishops. The Lords Temporal consist of all the Peers of the realm; the Bishops, however, are merely Lords of Parliament. Some of the Peers sit by *descent*, as do all ancient Peers; some by *creation*, as do all the new made ones: others, since the union with Scotland, by *election*, as the 16 Peers who represent the Scottish nobility. The number of the Peers is indefinite, and may be increased at will by the power of the Crown.

(2.) The Commons consist of all Members of Parliament who have not seats in the House of Lords.

(3.) The number of English representatives is 513, of Irish 100, and of Scotch 45—in all 658. And every Member, though chosen by one particular district, when elected and returned, serves for the whole realm. For the

end of his coming hither is not particular, but general; not merely to serve his constituents, but also the commonwealth, and to advise his Majesty, as appears from the writ of summons.

3. Parliament hath sovereign and uncontrolable authority in making, confirming, enlarging, restraining, abrogating, repealing, reviving, and expounding laws, concerning matters of all possible denominations, ecclesiastical or temporal, civil, military, maritime, or criminal. That absolute despotic power, which must in all governments reside somewhere, is here entrusted by the British Constitution. All mischiefs and grievances, operations and remedies, that transcend the ordinary course of the laws, are within the reach of this extraordinary tribunal.

Observation. Some of the most important privileges of the Members of either House are, privilege of speech, of person, of their domestics, and of their lands and goods.

4. The House of Lords has a right to be attended by the Judges of the courts of King's Bench and Common Pleas, and such of the Barons of the Exchequer, as are of the degree of the coif, or have been made Serjeants at Law, as likewise by the Masters of the Court of Chancery; for their advice in points of law, and for the greater dignity of their proceedings.

Observation. The Speaker of the House of Lords is generally the Lord Chancellor, or Lord Keeper of the Great Seal; these dignities being commonly vested in the same person.

5. The House of Commons may be properly styled the Grand Inquest of Great Britain, empowered to enquire into national grievances, in order to see them redressed.

6. To bring a bill into the House of Commons, if the relief sought by it is of a private nature, it is first necessary to prefer a petition; which usually sets forth the grievance desired to be remedied.

Observation. (1.) The giving the royal assent to bills is a matter of great form. When the King is to pass bills in person, he appears on his throne in the House of Peers, in his royal robes, with the Crown on his head, and attended by his Great Officers of State, and heralds.

(2.) The titles of bills that have passed both houses are read; and the King's answer, is declared by the clerk of the Parliament, in Norman French. If the King consents to a public bill, the clerk usually declares *le roy le veut*, "the King wills it so to be;" if to a private bill, *soit fait comme il est desiré*, "be it as it is desired;" if the King refuses his assent, it is in the gentle language of *le roy s'avisera*, "the King will advise upon it."

2. *The Privy Council and Great Officers of the Crown.*

The King of Britain, besides his High Court of Parliament, has subordinate officers and ministers to assist him, and they are responsible for their advice and conduct. The King nominates them without either patent or grant; and on taking the necessary oaths, they become immediately Privy Counsellors, during his life time; but subject to removal at his direction.

A Privy Counsellor's duty is obvious from the oath of

office, which consists of seven articles: 1, to advise the King according to the best of his cunning and discretion; 2, to advise for the King's honour and the good of the public, without partiality through affection, love, need, doubt, or dread; 3, to keep the King's council secret; 4, to avoid corruption; 5, to help and strengthen the execution of what shall be there resolved; 6, to withstand all persons who would attempt the contrary; and lastly, to observe, in general, all that a good and true counsellor ought to do for his sovereign Lord.

The Great Officers of the Crown are nine in number, who by their posts take place next to the Princes of the Royal Family and the two primates.

1. The first is the *Lord High Steward* of England, a very ancient office that was formerly hereditary, or at least for life. It is now exercised only occasionally, as at a coronation, or when it is necessary to sit as judge on a Peer or Peeress tried for a capital offence. On coronations it is held for that day only, by some high nobleman. In cases of trial it is exercised generally by the Lord Chancellor, or Lord Keeper, and it ends with the trial, by breaking his white rod, the badge of his office.

2. The *Lord High Chancellor* presides in the court of Chancery, to moderate the severities of the law, in all cases where the property of the subject is concerned; he determines according to the dictates of equity and reason.

3. The *Lord High Treasurer* has the management and charge of all the revenues of the Crown kept in the Exchequer; as also letting the leases of all Crown lands, and the gift of all places belonging to the customs in the several parts of the kingdom.

4. The *Lord President of the Council*, has precedence next after the Lord Chancellor, and Lord Treasurer. His duty is to propose all the business transacted at the

council-board, and to report to the King, when his Majesty is not present, all its debates and proceedings.

5. The *Lord Privy Seal's* duty is to put the King's seal to all charters, grants, and the like, which are signed by the King, in order to their passing the Great Seal.

6. The office of *Lord Great Chamberlain* of England is hereditary in the Duke of Ancaster's family. He attends the King, on his coronation, to dress his royal person. He has likewise charge of the House of Lords, during the sitting of Parliament; and the fitting up of Westminster-hall for coronations, or trials of Peers.

7. The office of *Lord High Constable* has been disused since the attainder and execution of Stafford, Duke of Buckingham, in the year 1521, but it is occasionally revived at a coronation.

8. The Duke of Norfolk, hereditary *Earl Marshal* of England, regulates all points of precedency according to the archives kept in the herald's office: this office is entirely within his jurisdiction. He directs also all solemn processions, coronations, proclamations, general mournings, and the like.

9. The office of *Lord High Admiral* of England (held by commission) is equal in importance to any of the preceding, especially since the amazing increase of our naval power.

Questions for Examination.

1. In whom is the supreme and executive power of the British Empire vested?

What is the fundamental maxim upon which the right of succession is founded?

How does the King of Great Britain rank? what extensive powers does he possess?

2. What is the Parliament? what are the Lords Spiritual and Temporal? what the Commons? and what the number of representatives for England, Ireland and Scotland?

3. What authority does parliament possess? and what are some of the privileges of the members of either house?

4. By whom is the House of Lords attended? and who is its speaker?

5. What may the House of Commons be properly styled?

6. What forms are gone through in bringing bills into Parliament? and giving them, when passed, the royal assent? and in what language is that assent given?

7. What is the privy council? and what is the oath of a privy counsellor, from which his duty may be learned?

8. What are the offices and duties of the nine great Officers of the Crown: the Lord High Steward, the Lord High Chancellor, the Lord High Treasurer, the Lord President of the Council, the Lord Privy Seal, the Lord Great Chamberlain, the Lord High Constable, the Earl Marshal, and the Lord High Admiral?

3. *The Courts of Law.*

1. The *Court of Chancery* is a court of equity, and is next in dignity to the High Court in Parliament. This court is designed to relieve the subject against frauds, breaches of trust, and other oppressions, and in some instances to mitigate the rigour of the law. The Lord High Chancellor sits as sole Judge, and in his absence the Vice Chancellor and the Master of the Rolls.

2. The *Court of King's Bench* is so called, because the Kings of England anciently sat there in person, or more properly, because all matters determinable by *common* law between the King and his subjects are there tried, except such affairs as properly belong to the Court of Exchequer.

Observation. This Court is a check upon inferior Courts of Justice throughout the realm; appointing or removing Country Justices at pleasure, as well as practitioners in the law. Four judges preside over this Court; the first is styled Lord Chief Justice of the King's Bench, or Lord Chief Justice of England, to express the great extent of his jurisdiction; the other three Judges are simply Justices or Judges of the King's Bench.

3. The *Court of Common Pleas* takes cognizance of all civil actions between subject and subject. The first Judge of this Court is styled Lord Chief Justice of the Common Pleas; and besides him, there are three other Judges. None but Serjeants at Law plead here.

4. The *Court of Exchequer* takes cognizance of all actions touching the revenues of the Crown, and it has a power of judging both according to law and equity. Its Judges are styled Barons, because formerly none but Barons of the Realm were Judges of this Court.

5. *Courts of Conscience* are for the relief of the poor, in the recovery of small debts not exceeding *forty* shillings.

6. In every county there is a *High-Sheriff*, whose office is both ministerial and judicial. The High Sheriff is annually appointed by the King to put the laws in force against evil doers.

7. The next office to the Sheriff is that of *Justice of Peace*, several of whom are commissioned for each county.

8. Each county has two *Coroners* who enquire, by a jury of neighbours, how, and by whom,

any person came by a violent death, and to enter it on record as a plea of the crown.

9. A *Constable*, a very ancient and respectable officer of the peace, under the English constitution, acts under the Sheriff or Justice.

4. *The Civil Government of Cities.*

10. The civil government of *Cities* is a small independency of their own, every city having by charter from the king, a jurisdiction within itself, to judge in all matters civil and criminal. It is subject, however, to this restraint, that all civil causes may be removed from the courts of cities to those at Westminster, and all offences that are capital are tried by the judge of the assize or circuit.

Observation. (1.) The government of cities differs according to their different charters, immunities and constitutions. They are constituted with a Mayor, Aldermen, and Burgesses, who, together, make the corporation of the city, and hold a court of judicature, where the Mayor presides as judge.

(2.) The government of incorporated *Boroughs* is much after the same manner.

11. All England is divided into six circuits, each containing a certain number of counties, as follow:

The Home Circuit.

Embracing Essex, Hertford, Kent, Surry and Sussex.

The Norfolk Circuit.

Bucks, Bedford, Huntingdon, Cambridge, Suffolk and Norfolk.

The Oxford Circuit.

Oxford, Berks, Gloucester, Worcester, Monmouth, Hereford, Salop and Stafford.

The Midland Circuit.

Warwick, Leicester, Derby, Nottingham, Lincoln, Rutland and Northampton.

The Western Circuit.

Hants, Wilts, Dorset, Somerset, Devon and Cornwall.

The Northern Circuit.

York, Durham, Northumberland, Lancaster, Westmoreland and Cumberland.

Observation. Middlesex and Chester are not comprised in these circuits, the former being the seat of the supreme courts of judicature, and the latter a county Palatine, having a separate judge.

5. *Trial by Jury.*

12. Every man imprisoned has a right to bring a writ called Habeas Corpus before a Judge at Westminster hall. If that judge find the offence bailable, the party is immediately admitted to bail, till he is condemned or acquitted in a court of justice.

The rights of individuals are so attentively considered, that the subject may, without the least danger, sue his Sovereign, or those who act in his name, and under his authority. He may do this in open court, where the King may be cast, and be obliged to pay damages to his subject.

13. If a man is charged with a *capital* offence, he does not undergo the ignominy of trial for his life, till the evidences of his guilt are laid before the *Grand Jury* of the town or county, in which the fact is alleged to have been committed. Nor is he put upon his trial unless twelve of them agree to a bill of indictment against him. If they do this, he is to stand a second trial before twelve other men whose opinion is definitive.

Observation. These are called a special Jury, but in general, simply *the Jury*. And they are the Judges from whose sentence the prisoner is to expect life or death. Upon their integrity and understanding, the lives of all, who are brought into danger, ultimately depend; and from their judgment there lies no appeal. They must therefore be all of one mind. After they have fully heard the evidence, they are confined in a room, without meat, drink, or candle, till they are unanimous in acquitting or finding the prisoner guilty.

14. IN THE TRIAL OF A MALEFACTOR, the court being met, and the prisoner called to the bar, the clerk commands him to hold up his hand, and then charges him with the crime of which he is accused, asking him, Whether he is *guilty* or *not guilty?*

Observation. (1.) If the prisoner answer *guilly*, the trial is at an end. But if he answer *not guilty*, the court proceeds on the trial, even though he may before have confessed the fact; for the law of England takes no notice of such confession. If the witnesses who are upon oath fail to prove him guilty of the crime, the Jury acquit him; for they are directed to bring in their verdict, according to the *evidence given in Court.*

(2.) All prisoners *not found guilty* by the Jury are immediately acquitted and discharged, and in some cases obtain from the court a copy of their indictment, to proceed at law against their prosecutors.

6. *Legal Punishments.*

15. The law of England includes all capital crimes under *high treason, petty treason,* and *felony*. The first consists in plotting, conspiring, or rising up in arms against the Sovereign, or counterfeiting the coin of the realm.

Observation. For the coining of money which is adjudged high treason, the criminal is hanged. Though the sentence passed upon all traitors is the same; yet with respect to persons of quality the punishment is generally altered to beheading.

16. The punishment for *misprision* of high treason, that is to say for neglecting or concealing high treason, is imprisonment for life, the forfeiture of all the offender's goods, and the profits arising from his lands.

17. *Petty treason* is when a child kills his father, a wife her husband, a clergyman his bishop, or a servant his master or mistress.

Observation. This crime is punished by hanging.

18. *Felony* includes murders, robberies, forging notes, bonds, deeds and the like, which are all punished by hanging; and murderers are executed within 24 hours after sentence is pronounced, and their bodies delivered to surgeons to be publicly dissected.

But as Sunday is not reckoned a *day*, they are generally tried on Friday, so that they obtain a respite till Monday. Persons guilty of robbery when there are some alleviating circumstances are either transported, or condemned to hard labour in works of public utility, upon the river Thames, &c. for a certain number of years.

19. *Manslaughter* is the unlawful killing of a person without premeditated malice, but with a present intent to kill; as when two, who formerly meant no harm to each other, quarrel, and the one kills the other.

Observation. In this case the criminal is allowed the benefit of his clergy for the first time, and only burnt in the hand.

20. *Chance-medley* is the accidental killing of a man without an evil intent, for which the offender is also to be burnt in the hand. But if the offender were doing an unlawful act, the punishment is death.

21. *Shop-lifting*, and receiving goods knowing them to have been stolen, are punished with hard labour for a number of years, or burning in the hand.

22. *Perjury* or the taking of a false oath, is punished with the pillory, imprisonment, banishment and death.

23. *Petty larceny*, or small theft, under the value of 12*d*. is punished by whipping.

24. *Libelling* or the publishing of defamatory reports, is now punished by fines and imprisonment; using false weights and measures, and

orestalling the *markets*, are commonly punished by standing on the pillory.

25. For *striking* so as to *draw blood* in the King's Court, the criminal is punished by losing his right hand. For *striking* in *Westminster Hall*, while the Courts of Justice are sitting, the punishment is imprisonment for life, and forfeiture of all the offender's estates. *Drunkards*, vagabonds, and loose disorderly persons, are punished by being set in the stocks, or by paying a fine.

Note. Tutors and Parents in possession of Blackstone's Commentaries of the Laws of England, or an Encyclopædia will be enabled to furnish youth with more ample details of this chapter; though what we have given will not be considered scanty in a volume embracing so great a variety of subjects.

Questions for Examination.

1, 2. Describe the Courts of Chancery and King's Bench.

3, 4. Also the Court of Common Pleas and Court of Exchequer.

5. What are Courts of Conscience?

6, 7, 8, 9. What are the offices and duties of High Sheriffs, Justices of the Peace, Coroners, and Constables?

10. Give the particulars of the civil government of cities, and say how it differs according to different charters?

11. Also the circuits or assizes and the counties each assize includes?

12. Detail the particulars of trial by jury, and say how the rights of individuals are considered?

13. What are the duties of Grand and of Special Juries?

14. How is the trial of a malefactor conducted? and what happens to those acquitted?

15. Under what names does the law of England include all capital crimes? and what is the punishment of high treason?

16, 17, 18. What also are misprision, petty treason, and felony, and the punishments the law awards to those found guilty of those crimes?

19, 20. What are manslaughter and chance-medley, and the punishment awarded to those found guilty of either?

21, 22, 23. What are shop-lifting, perjury, petty larceny; and the punishment of those found guilty of either?

24, 25. What is libelling? how punished? What is the punishment for striking so as to draw blood, in the King's Court? for striking also in Westminster Hall while the courts are sitting? and how are drunkards, &c. punished?

CHAPTER XIII.

Geometry.

Geometry is the science and doctrine of local extension, as of lines, surfaces, and solids, with that of ratios, &c.

Observation. The name geometry literally signifies *measuring of the earth*, as it was the necessity of measuring the land that first gave occasion to contemplate the principles and rules of this science, which has since been extended to numberless other speculations. The usefulness of this science, extends generally to the arts and sciences; for by its help astronomers turn their observations to advantage, ascertain the duration of times, seasons, years, cycles, and epochas; and measure the distance, motions, and magnitudes of the heavenly bodies; by it also geographers determine the figure and magnitude of the whole earth, and delineate the extent and bearings of kingdoms, provinces, harbours, &c. From this science too, architects derive their just measures, in the construction of edifices. By the assistance of geometry, engineers conduct all their works, take the situation and plans of towns, the distances of places, and the measure of such things as are only accessible to the sight. Geometry is also highly necessary to mechanics, especially to carpenters, joiners, mathematical instrument-makers, and all who profess designing. On geometry likewise depends the theory of music, optics, perspective, drawing, mechanics, hydraulics, pneumatics, &c.

Herodotus and Proclus ascribe the invention of geometry to the Egyptians, and assert that the annual

inundations of the Nile gave occasion to it; for those waters bearing away the bounds and land-marks of estates and farms, covering the face of the ground uniformly with mud, the people say, that they were obliged every year to distinguish and lay out their lands by the consideration of their figure and quantity; and thus, by experience and habit, they formed a method or art, which was the origin of geometry. A farther contemplation of the drafts of figures of fields, thus laid down, and plotted in proportion, might naturally lead them to the discovery of some of its excellent and wonderful properties; which speculation continually improving, the art continually gained ground, and made advances more and more towards perfection.

Geometry is distinguished into theoretical or speculative, and practical.

Theoretical or speculative geometry treats of the various properties and relations of magnitudes in the demonstration of theorems.

Practical geometry applies those speculations and theorems to particular uses in the solution of problems, and in the measurements in the ordinary concerns of life.

Speculative geometry, again, may be divided into elementary and sublime.

Elementary or common geometry, is that which is employed in the consideration of right lines and plane surfaces, with the solids generated from them. And the higher or sublime geometry, is that which is employed in the consideration of curve lines, conic sections, and the bodies formed of them. This part has been chiefly cultivated by the moderns, by the help of the improved state of the modern analysis of algebra and fluxions.

Definitions. 1. A *definition* is a short and plain description of a thing by its properties.

2. An *axiom* is a self-evident truth, which commands universal assent, as soon as it is understood.

3. A *postulate* is a demand that certain simple opera

tions, the possibility and manner of effecting which are self-evident, may be admitted to be practicable.

4. A *proposition* is either something proposed to be done, or some truth to be demonstrated. In the first case, the proposition is called a *problem*, and in the latter a *theorem.*

When from supposed premises, a theorem asserts certain consequences and subjoins, " and conversely ;" it is to be understood, that if the consequences be assumed as premises, then what were first taken as premises, will become consequences.

5. A *demonstration* is a clear and connected series of reasoning, founded on truth, either self-evident, or previously established, which irresistibly convinces the mind of the truth proposed.

6. A *direct demonstration* is that which proceeds from the premises by a regular deduction of truth from truth, till the truth of the proposition advanced is clearly made out.

7. An *indirect demonstration*, is that which proves a proposition to be true, by showing that some absurdities must necessarily follow if it were false.

8. A *corollary* is a consequence which results easily and irresistibly from the doctrine of a proposition.

9. A *lemma* is a preparatory proposition laid down to simplify the demonstration of the main proposition which follows it.

10. A *scholium* is a note added to illustrate, extend, or apply some preceding doctrine.

11. A *mathematical point* has neither length, breadth, nor thickness.

12. A *line* is length without breadth or thickness.

13. *Parallel lines* are such as always keep at the same distance from each other, and which if prolonged ever so far, would never meet.

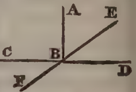
14. A *right line* is what is commonly called a straight line, or one that tends every where the same way.

15. A *curve* is a line which continually changes its direction between its extreme points.

16. An *angle* is the inclination or opening of two lines meeting in a point.

The lines A B, and B C, which form the angle, are called the *legs* or *sides;* and the point B, where they meet, is called the *vertex* of the angle, or the angular point. An angle is sometimes expressed by a letter placed at the vertex, as the angle at B in the foregoing figure, but most commonly by three letters; observing to place in the middle the letter at the vertex, and the other two are those at the end of each leg, as the angle A B C.

17. When one line stands upon another, so as not to lean more to one side than to another, both the angles which it makes with the other, are called *right angles*, as the angles AB C, A B D, which stand at *right angles*, are equal to each other, being each equal to 90°; and the line A B is said to be *perpendicular* to C D.



18. When one line, B E, stands upon another, C D, so as to incline, the angle E B C, which is greater than a right angle, is called an *obtuse* angle; and that which is less than a right angle is called an *acute* angle, as the angle E B D.

19. Two angles, which have one leg in common as the angles A B C and A B E, are called *contiguous angles*, or *adjoining* angles; those which are produced by the crossing of two lines, as the angles, E B D, and C B F, formed by C D and E F crossing each other, are called *opposite* or vertical angles.

20. A *figure* is a bounded space, and is either a surface or a solid.

21. A *superficies*, or surface, has length and breadth only. The extremities of a superficies are lines.

22. A *plane*, or plane surface, is that which is every where perfectly flat and even, or which will touch every part of a straight line, in whatever direction it may be

laid upon it. The top of a marble slab, for instance, is an example of this, which a straight edge will touch in every point, so that you cannot see light any where between these.

23. A *curved* surface is that which will not coincide with a straight line in any part. Curved surfaces may be either convex or concave.

24. A *convex* surface is when the surface rises up in the middle; as for instance, a part of the outside of a globe.

25. A *concave* surface is when it sinks in the middle, or is hollow, and is the contrary to convex.

26. A surface may be bounded by straight lines, curved lines, or both of these.

27. Every surface bounded by straight lines only is called a *polygon*. If the sides are all equal, it is called a *regular* polygon. If they are unequal it is called an *irregular* polygon.

28. Every polygon, whether equal or unequal, has the same number of sides as angles, and they are denominated sometimes from the number of sides and sometimes from the number of angles they contain. Thus a figure of three sides is called a *triangle*, and a figure of four sides a *quadrangle*.

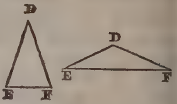
29. A *pentagon* is a polygon of *five* sides; a *hexagon* has *six* sides; a *heptagon*, *seven* sides; an *octagon*, *eight* sides; a *nonagon*, *nine* sides; a *decagon ten* sides; an *undecagon*, *eleven* sides; a *duodecagon*, *twelve* sides.

30: When they have a greater number of sides they are usually called polygons of thirteen sides, of fourteen sides, and so on.

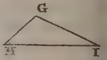
31. Triangles are of *different* kinds according to the length of their sides.

32. An *equilateral* triangle has all its sides equal, as A B=B C=C A; and the angles A, B, C are each=60°; for the 3 angles of every triangle are equal to 2 right angles.

33. An *isosceles* triangle is one that has two equal sides, as D E F.



34. A *scalene* triangle has all its sides unequal as G H I.

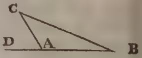


35. Triangles are also denominated according to the angles they contain.

36. A *right angled* triangle is one that has in it a right angle, as A B C.

37. A triangle cannot have more than one right angle. The side opposite to the right angle B, as A C, is called the *hypothenuse*, and is always the longest side.

38. An obtuse angled triangle has one obtuse angie in it, as A.



39. An *acute* angled triangle has all its angles *acute*.

40. An *isosceles*, or a *scalene* triangle, may be either right angled, obtuse or acute. Any side of a triangle is said to subtend the angle opposite to it: thus A B (36.) subtends the angle A C B.

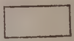
41. If the side of a triangle be drawn out beyond the figure, as A D, (38.) the angle A or C A B, is called an *internal* angle, and the angle C A D, or that without the figure an *external* angle.

42. A *quadrangle* is called also a quadrilateral figure. These are of various denominations, as their sides are equal or unequal, or as all their angles are right angles or not.

43. Every four sided figure whose sides are parallel,

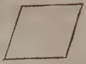
is called a *parallelogram.* Provided that the sides opposite to each other be parallel, it is immaterial whether the angles are right or not.

44. When the angles of a parallelogram are all right angles, it is called a rectangular parallelogram, or a rectangle.



45. A rectangle may have all its sides equal, or only the opposite sides equal. When all its sides are equal, it is called a *square.*

46. When the opposite sides are parallel, and all the sides equal to each other, but the angles not right angles, the parallelogram is called a rhomb.



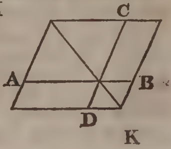
47. A parallelogram having all its angles oblique, and only the opposite sides equal, is called a rhomboid.

48. When a quadrilateral, or four-sided figure has none of its sides parallel, it is called a *trapezium,* consequently every quadrangle or quadrilateral, which is not a parallelogram, is a trapezium.

49. A *trapezoid* has only one pair of its sides parallel.

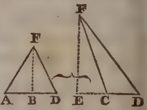
50. A *diagonal* is a right line drawn between any two angles that are opposite in a polygon as, I K. In parallelograms the diagonal is sometimes called the diameter, because it passes through the centre of the figure.

Complements of a parallelogram. If any point be taken in the diagonal of a parallelogram; and through that point two lines are drawn parallel to the sides, as A B, C D, it will be divided into four parallelograms, B D, D A, A C, C B. The two divisions, D A, C B, through which the diameter does not pass, are called the complements.



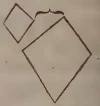
51. The *base* of a figure, is the side on which it is supposed to stand erect, as A D, and C D.

52. The *altitude* of a figure is its perpendicular height from the base to its highest part, as E F.



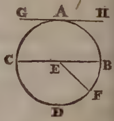
53. The *area* of a plane figure or other surface, means the quantity of space contained within its boundaries, expressed in square *feet*, *yards*, or any other superficial measure.

54. *Similar* figures are such as have the same angles, and whose sides are in the same proportion.



55. *Equal* figures are such as have the same area or contents.

56. A *circle* is a plane figure, bounded by a curve returning into itself, called its circumference, A B C D.



57. The *radius* is the opening of the compass when the circle is described; and consequently all the radii of a circle must be equal to each other, as B E, F E.

58. A *diameter* of a circle is a straight line drawn from one side of the circumference to the other through the centre, as C B. Every diameter divides the circle into two equal parts.

59. A *segment* of a circle, is a part of a circle cut off by a straight line drawn across it. This straight line is called the *chord*. A segment may be either equal to, greater or less, than a semicircle, which is a segment

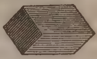
formed by the diameter of the circle, as C A B, and is equal to half the circle.

60. A *tangent* is a strait line drawn so as just to touch the circle without cutting it, as G H. The point A, where it touches the circle, is called the point of contact. And a tangent cannot touch a circle in more points than one.

61. A *sector* of a circle, is a space comprehended between two radii and an arc, as I K.

62. The circumference of every circle whether great or small is supposed to be divided into 360 equal parts, called *degrees;* and every degree into 60 parts, called *minutes;* and every minute into sixty *seconds.* To measure the inclination of lines to each other or angles, a circle is described round the angular point as a centre; and according to the number of degrees, minutes, and seconds, cut off by the sides of the angle, so many degrees, minutes and seconds, it is said to contain. Degrees, minutes and seconds, are conveniently marked thus, $48^\circ\ 15'\ 7''$, which we read forty eight degrees, fifteen minutes, seven seconds.

63. A *solid* body is any body that has length, breadth and thickness: a book, for instance, is solid, so is a sheet of paper, for though its thickness is very small yet it has some thickness. The boundaries of a solid are surfaces.



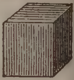
64. *Similar* solids are such as are bounded by an equal number of similar planes.

65. A *prism* is a solid of which the sides are parallelograms, and the two ends or bases, are similar polygons, parallel to each other. Prisms are denominated according to the number of angles in the base, triangular prisms, quadran-

rangular, heptangular and so on. If the sides are perpendicular to the plane of the base, it is called an upright prism, if they are inclined it is called an *oblique prism.*

66. When the base of a prism is a *parallelopipedon,* the solid is terminated by six parallelograms.

67. When all the sides of a parallelopipedon are squares, the solid is called a *cube.*



68. A *rhomboid* is an oblique prism, whose bases are parallelograms.

69. A *pyramid* is a solid, bounded by or contained within, a number of planes, whose base may be any polygon, and whose faces terminate in one point, B, commonly called the vertex of the pyramid.

70. When the figure of the base is a triangle, it is called a *triangular pyramid ;* when the figure of the base is quadrilateral, it is called a *quadrilateral pyramid,* &c.

71. A pyramid is either *regular* or *irregular*, according as the base is regular or irregular.

72. A pyramid is also *right* or *upright*, or it is oblique.

It is *right* when a line drawn from the vertex to the centre of the base is perpendicular to it. And oblique when it inclines.

73. A *cylinder* is a solid generated or formed by the rotation of a rectangle about one of its sides, supposed to be at rest: this quiescent side is called the axis of the cylinder. Or it may be conceived to be generated by the motion of a circle, in a direction perpendicular to its surface, and always parallel to itself.

74. A cylinder is either *right* or *oblique*, as the axis is perpendicular to the base, or inclined.

75. Every section of a right cylinder taken at right angles to its axis, is a circle; and every section taken across the cylinder, but oblique to the axis is an ellipsis.

76. A circle being a polygon of an infinite number of sides, it follows that the *cylinder* may be conceived as a prism, having such a polygon for a base.

A

77. A *cone* is a solid, having a circle for its base, and its sides a convex surface terminating in a point, A, called the vertex or apex of the cone. It may be conceived to be generated by the revolution of a right angled triangle about its perpendicular.

78. A line drawn from the vertex to the *centre* of the base is the *axis* of the cone.

A

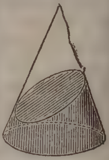
79. When this line is perpendicular to the base, the cone is called an *upright*, or *right cone*; but when it is inclined, it is called an *upright oblique cone.*

80. If it be cut through the axis from the vertex to the base, the section will be a *triangle.*

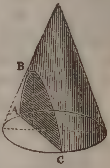
81. If a right cone be cut by a plane at right angles to the axis, the section will be a *triangle.*

82. If a right cone be cut by a plane at right angles to the axis, the section will be a *circle*.

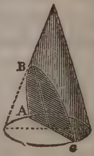
83. If it be cut oblique to the axis, and quite across from one side to the other, the section will be an *ellipsis*. A section of a cylinder made in the same manner, is also an ellipsis; and that is easily conceived: but it does not appear so readily to most people, that the oblique section of a cone is an ellipsis: they frequently imagine that it will be wider at one end than the other, or what is called an oval, which is the shape of an egg. But that this is a mixtake, any one may convince himself by making a cone, and cutting it across obliquely; it will then be seen that the section in whatever direction it is taken, is a regular ellipsis; and this is the case whether the cone be right or oblique, except only in one case in the oblique cone; which is when the section is taken in a particular direction, which is called subcontrary to its base.



84. When the section is made parallel to one of the sides of the cone, the curve A B C, which bounds the section is called a *parabola*.



85. When the section is taken parallel to the axis, the curve is called an *hyperbola*. These curves, which are formed by cutting a cone in different directions, have various properties, which are of great importance in astronomy, gunnery, perspective, and many other sciences.



86. A *sphere* is a solid terminated by a onvex surface, every point of which is at n equal distance from a point within, called ne centre. It may be conceived to be ormed by making a semicircle revolve round s diameter. This may be illustrated by the process of orming a ball of clay by the potters' wheel, a semicir-ular mould being used for the purpose. The diameter f the semicircle round which it revolves is called the xis of the sphere.

87. The ends of the axis are called *poles*.

88. Any line passing through the centre of the sphere, nd terminated by the circumference, is a *diameter* of he sphere.

89. Every section of a sphere is a *circle*; every sec-ion taken through the centre of the sphere is called a *reat* circle, as A B; every other is a *lesser* circle, as C D. (86.)

90. Any portion of a sphere cut off by a plane, is alled a *segment*; and when the plane passes through he centre, it divides the sphere into two equal parts, each of which is called a *hemisphere*.

91. A *spheroid* is a solid, generated by the otation of a semi-ellipsis about the transverse or conjugate axis; and the centre of the ellipsis is the centre of the spheroid.

92. The line about which the ellipsis revolves is called the axis. If the spheroid be generated about the con-jugate axis of the semi-ellipsis, it is called a *prolate* spheroid. If the spheroid be generated by the semi-ellipsis by revolving about the transverse axis, it is call-ed an *oblong* spheroid.

93. Every section of a spheroid is an *ellipsis*, except when it is perpendicular to that axis about which it is generated; and in that case it is a *circle*.

94. All sections of a spheroid parallel to each other are *similar* figures.

95. A *frustrum* of a solid, means a piece cut off from

the solid by a plane passed through it, usually parallel to the base of the solid, as the frustrum of a cone, a pyramid, &c.

96. There are a *lower* and an *upper frustrum*, according as the piece spoken of does or does not contain the base of the solid.

97. *Ratio* is the proportion which one magnitude bears to another of the same kind, with respect to quantity, and is usually marked thus, A: B ; that is A is to B. Of these the first is called the *antecedent* and the other the *consequent*.

98. The measure or quantity of a ratio is conceived by considering what part of the consequent is the antecedent; consequently it is obtained by dividing the consequent by the antecedent.

99. *Three* magnitudes or quantities A B C, are said to be proportional, when the ratio of the first to the second is the same as that of the second to the third. Thus 2, 4, 8, are proportional; because 4 is contained in 8 as many times as 2 is in 4.

100. *Four* quantities A, B, C, D are said to be proportional, when the ratio of the first A to the second B, is the same as the ratio of the third C to the fourth D; and it is usually written A : B : : C : D, or if expressed in numbers, 2 : 4 : : 8 : 16.

101. Of *three proportional* quantities the *middle* one is said to be a *mean proportional* between the other two, and the last a *third* proportional to the *first* and *second*.

102. Of *four* proportional quantities the *last* is said to be a *fourth*, proportional to the other three taken in order.

103. Ratio of *equality* is that which equal numbers bear to each other.

104. *Inverse* ratio is when the antecedent is made the consequent, and the consequent the antecedent, thus if, 1 : 2 : : 3 : 6; then, inversely 2 : 1 : : 6 : 3.

105. *Alternate* proportion is when *antecedent* is compared with antecedent, and *consequent* with consequent. Thus, if 2 : 1 : : 3 : 6 then by alteration 2 : 6 : : 1 : 3.

106. Proportion by composition is when the antecedent and consequent taken as one quantity are compared ther with the consequent or antecedent.

107. *Divided* proportion is when the difference of the antecedent and consequent is compared either with the consequent or with the antecedent, thus if 3:1::12:4, ien by division 3—1:1::12—4:4 and 3—1:3::12—4:2.

108. *Continued* proportion is when the first is to the second, as the second to the third, as the third to the ourth, as the fourth to the fifth, and so on

109. *Compound* ratio is formed by the multiplication of everal antecedents and the several consequents of atios together in the following manner:

If A be to B as 3 to 5, B to C as 5 to 8, and C to D as 3 to 6: Then will A be to D as $\frac{3\times5\times8}{5\times8\times6}=\frac{120}{240}=\frac{1}{2}$; hat is, A:D::1:2.

110. *Bisect* means to divide any thing into two equal parts.

111. *Trisect* is to divide any thing into three equal parts.

112. *Inscribe* is to draw one figure within another, so that all angles of the inner figure touch either the angles, planes, or sides of the external figure.

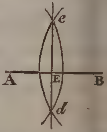
113. *Circumscribe* is to draw a figure round another, so that either the angles, sides or planes of the circumscribed figure, touch all the angles of the figure within it.

114. *Rectangle* under any *two lines*, means a rectangle which has two of its sides equal to one of the lines, and two of them equal to the other. Also the rectangle under A B. C D means A B$\times$C D.

115. *Scales of equal parts.* A scale of equal parts, is only a straight line, divided into any number of equal parts at pleasure. Each part may represent any measure you please, as an *inch*, a *foot*, a *yard*, &c. One of these is generally subdivided into parts of the next denomination, or into *tenths* or *hundredths*. Scales may be constructed in a variety of ways. The most usual man-

ner is to make an inch, or some aliquot part of an inch, to represent a foot, and then they are called inch scales three quarter inch scales, half inch scales, quarter inch scales, &c. They are usually drawn upon ivory or box-wood.

Geometrical Problems.

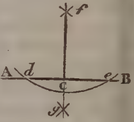


Prob. 1. *To divide a given Line A B into two equal parts.*

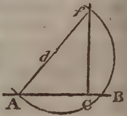
From the points A B, as centres, and with any opening of the compasses, greater than half A B, describe arches, cutting each other in *c d*. Draw the Line *c d*; and the point E, where it cuts A B, will be the *middle* of the line as required.

Prob. 2. *To raise a perpendicular to a given line A B, from a point given at C.*

Case 1. When the given point is near the middle of the line on each side of the point C, take any two equal distances, C *d*, and C *e* with any radius, greater than C *d*, or C *e*, describe two arches cutting each other in *f*. Lastly, through the points *f* C. draw the line *f* C and it will be the perpendicular required.



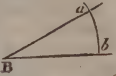
2. When the point is at or near the end of the line, take any point *d*, above the line, and with the radius or distance *d* A, describe the arc, A C *f*, cutting A B, in A and C. Through the centre *d*, and the point A, draw the line A *d f*, cutting the arc, A C *f*, in *f*. Through the points *f* C, draw the line *f* C, and it will be the *perpendicular* required.



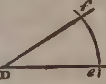
PROB. 3. *From a given point f to let fall a rpendicular upon a given line, A B. (See the g. of Prob. 2, case 1st.)*

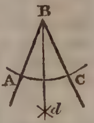
From the point *f* with any radius describe the arc *e*, cutting A B in *e*, *d*. From the points *e d*, with ie same or any other radius, describe two arcs, cutting ach other in *g*. Through the points *f* and *g* draw the ne *f g* which will be the *perpendicular* required.

PROB. 4. *To make an angle equal o another angle which is given, as , B, b.*



From the point B, with any radius, describe the arc *b*, cutting the legs, B *a*, B *b*, in the oints *a* and *b*. Draw the line D *e*, and rom the point D, with the same radius as efore, describe the arc, *e a*, cutting D *e*, n *e*. Take the distance *b a*, and apply it to the arc, *a*, from *e* to *a*. Lastly, through the points D *a*, draw he line D *a*, and the angle *e* D *a*, will be *equal* to the angle, *b* B *a*, as was required.

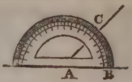




PROB. 5. *To divide a given angle, A B C into two equal angles.*

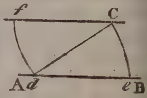
From the point B, with any radius, describe the arc, A C. From A and C, with the same or any other radius, describe arcs cutting each other in *d*, draw the line B *d*, and it will *bisect* the angle A B C as was required.

PROB. 6. *To lay down an angle of any number of degrees.*



There are various ways of doing this. One is by the use of an instrument called a *protractor;* with a semicircle of brass, having its circumference divided into degrees. Let A B be a given line, and let it be required to draw from the angular point A, any number of degrees, suppose 20° lay the straight side of the protractor, along the line A B, and count 20°, from the end (B) of the semicircle; at C, which is 20° from B, mark off these 20°; then removing the protractor draw the line A C, which makes with A the *angle* required.

Or it may be done by a divided line, usually drawn upon scales, called a line of chords. Take 60° from the line of chords in the compasses, and setting one foot at the angular point B, (*Prob.* 4.) with that opening as a radius describe an arch as *a b;* then take the number of degrees, you intend the angle to be of, and set it from *b* to *a*, then is *a* B *b*, the *angle* required.

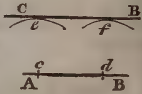


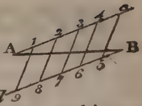
PROB. 7. *Through a point C to draw a line parallel to a given line A B.*

Case 1. Take any point *a*, in A, B; upon *a* and C, with the distance C *d*, describe two arcs, C *c*, and *d f*, cutting the line A B in *e* and *d*. Make *d f*, equal to C *c;* through C *f*, draw C *f*, and it will be parallel to A B, as was required.

2. *When the parallel line is to be at a given distance from the line A B.*

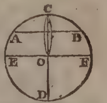
From any two points *c* and *d*, in the line A B, with a radius equal to the given distance, describe the arcs *e* and *f:* draw the line C B, to touch those arcs without cutting them, and it will be *parallel* to A B, as was required.





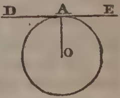
PROB. 8. *To divide a line A B into any proposed number of equal parts.*

From A, one end of the line, draw A *c*, making an angle with A B; and from B, the other end, draw B *d*, making the angle A B *d* equal to B A *c*. In each of these lines A *c*, B *d*, beginning at A and B, set off as many equal parts of any length as A B is to be divided into: join the points *c* 5, 4 6, 3 7, &c. and A B will be *divided* as required.



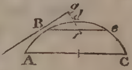
PROB. 9. *To find the centre of a given circle, or of any one already described.*

Draw any chord A B, and bisect it with the perpendicular C D, bisect C D with the diameter E F, and the intersection O will be the *centre* required.



PROB. 10. *To draw a tangent to a given circle, that shall pass through a given point A.*

From the centre O, draw the radius O A. Through the point A, draw D E, perpendicular to O A, and it will be the tangent required.

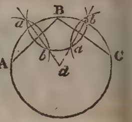


PROB. 11. *To draw a tangent to a circle or any segment of a circle A B C, through a given point B, without making use of the centre of the circle.*

Take any two equal divisions upon the circle from the given point B, towards *d* and *e*, and draw the chord *e* B. Upon B as the centre, with the distance B *d*,

describe the arc $f\ d\ g$, cutting the chord e B, in f. Make $d\ g$ equal to $d\ f$; through g draw g B, and it will be the *tangent* required.

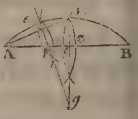
Prob. 12. *Given three points A, B, C, not in a straight line, to describe a circle that shall pass through them.*



Bisect the lines A B, B C, by the perpendiculars $a\ b$, $b\ a$, meeting at d. Upon d, with the distance $d\ a$, $a\ b$, describe A B C, which completed will be the required *circle*.

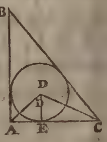
Prob. 13. *To describe the segment of a circle to any length A B, and any height C D.*

Bisect A B, by the perpendicular D g, cutting A B, in C. On the perpendicular line g D, make c D, equal to the given height. Draw A D, and bisect it by the perpendicular $e\ f$, cutting D g, in g; upon g, the centre, describe A D B, and it will be the required *segment*.

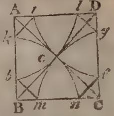


Prob. 14. *In any given triangle to inscribe a circle.*

Bisect any two angles, A and C, with the lines A D, and D C. From D, the point of intersection, let fall the perpendicular D E, it will be the radius of the circle required.



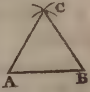
Prob. 15. *In a given square, to describe a regular octagon.*



Draw the diagonals, A C, and B D, intersecting at e, upon the points A, B, C, D, as centres, with a radius e C, describe the arcs, $k\ e\ r$, $m\ e\ g$, $f\ e\ i$, &c.; join $f\ n$, $m\ b$, $k\ i$, $l\ g$, and they will complete the required *octagon*.

Prob. 16. *In a given circle to describe any regular polygon.*

Divide the circumference into as many parts as there are sides in the *polygon* to be drawn, and join the points of division; and the construction will be completed.

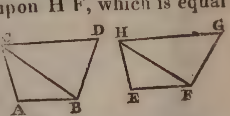


Prob. 17. *Upon a given line A B, to construct an equilateral triangle.*

Upon the points A, B, and with a radius equal to A B, describe arches cutting each other at C. Draw A C, and B C; and A B C will be the *triangle* required.

Prob. 18. *To make a trapezium equal and similar to a given trapezium A B C D.*

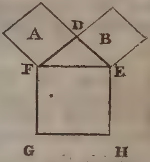
Divide the given trapezium A B C D, into two triangles, by the diagonal C B. Make E F equal to A B. Upon E F, construct the triangle E F H, whose sides shall be respectively equal to those of the triangle A B C, by the last problem; upon H F, which is equal to C B, construct the triangle H F G, whose sides are respectively equal to D B C; then, E F G H will be the *trapezium* required.



By this problem any plan may be copied; as every

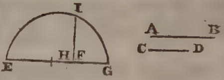
figure, however irregular, may be divided into triangles. Upon this, the practice of land surveying, and the making of plans of estates, are founded.

PROB. 19. *To make a square equal to two given squares.*



Make the sides D E, and D F, of the two given squares A and B, form the sides of a right angled triangle F D E. Draw the hypothenuse F E. On E F describe the square E F, G H, and it will be the square required.

PROB. 20. *Between two lines A B and C D, to find a mean proportional.*



Draw the right line E G, in which E F is equal to A B, and F G equal to C D. Bisect E G, in H, and with H E or H G, as a radius, describe the semicircle E I G. From F draw F I, perpendicular to E G, cutting the circle in I; and it will be the *mean proportional* required.

Note. On this chapter, we have not framed any questions, as it would only be a repetition of the definitions, &c. The good sense of the enlightened tutor will prescribe such interrogatories as may establish the pupil in a knowledge of this sketch of Elementary Geometry.

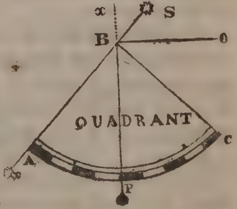
CHAPTER XIV.

Practical Mathematics.

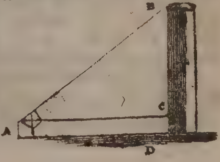
1. *The mensuration of Heights and Distances.*

The operations in this branch of the Mathematics are entirely founded on Trigonometry; and the principal instruments used are the theodolite and the quadrant.

The quadrant. A c is a quadrant of a circle divided into degrees, with sights in A B, to look at the object, and it is likewise furnished with a plummet, P. Now suppose a person to look at an elevated object S; the angle S B o, is the angle made by the object S and the horizon; but the angle S B c is equal to the angle P B c, therefore the arc P c measures the angle, which a line from the object to the person's eye and the horizon will make. Now suppose a person to look at a depressed object, x, then it is evident that A P must measure the angle made by a line from the object, x, to the person's eye, from the plumb line B P. And thus any angle, either elevated or depressed, may be measured.



Prob. 1. Wanting to know the height of a Tower, which stood on a horizontal plane, I measured back 80 feet, and found the line of elevation B A 54° 27′, the centre of the quadrant being 5 feet above the ground; and I found the height B D to be 117 feet, by the following trigonometrical proportion:



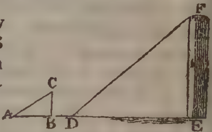
		Log.
As sine $\angle$ B,	$35^\circ, 35' =$	9.76448
is to A B	$=80^\circ$,	1.90309
so is sine $\angle$ A	$=54^\circ, 27' =$	9.91042
to C B	112 feet $=$	2.04903.*

112+5, (The height of the quadrant)=117 Feet.

Note. The following are some very simple and easy methods of measuring heights and distances.

PROB. 2. By means of the object's shadow.

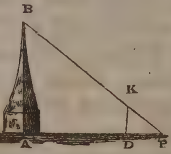
Suppose E D to be the shadow of the tower E F. Then at B erect a stick B C, of any known length, then measure both shadows.



As the rays of light, namely, A C and F D are parallel, so the two triangles A B C, and D E F, are similar; therefore, A B (= the stick's shadow): B C (= the stick's height) : : D E (= the object's shadow) : E F (its height).

PROB. 3. By means of one pole or stick.

Suppose it is wished to measure the height of the object A B, and the person has nothing to do it with but a walking-stick; let him measure from the foot of the object to any convenient distance, as A D; then set his stick perpendicularly, and lie down, putting his feet to it, with his eye, the stick, and the object in one line. Make a mark at P; then measure D P. He now knows A D, D P, and D K; he can find out A B, by similar triangles, for D P : D K : : A P : A B.



Note. The same methods may be easily applied to distances.

* The logarithm of the upper line is subtracted from the sum of the logarithms in the two middle lines, and the difference only is left = 2.04903.

2. *The Mensuration of Superficies,*

Or the mensuration of surfaces, is to determine how many squares of any dimension would cover a given surface.

Table of Square Measures.

144 square inches		= 1 square foot.
9 square feet		= 1 square yard.
22 yards	= 66 feet	= 1 English chain.
24 Scots ells	= 74 feet	= 1 Scots chain.
80 English chains		= 1 Mile.
8.88 inches		= 1 link of the Scots chain.
$7\frac{23}{25}$ or 7.92 inches		= 1 link of the English chain.
10 square chains		= 1 acre.

PROBLEM 1. *To find the area of a square.*

Rule. Multiply the side by itself, viz. square the side, and it gives the area.

PROB. 2. *To find the area of a rectangle.*

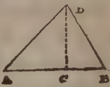
Rule. Multiply the length by the breadth, and it gives the area.

PROB. 3. *To measure the area of a parallelogram.*

Rule. Multiply one of the sides by the perpendicular distance between them, and you will have the area.

PROB. 4. *To find the area of a triangle.*

Rule 1. Multiply the base into half the perpendicular drawn from the vertex, and it gives the area. Thus, $AB \times \frac{CD}{2} =$ area.



Rule 2. The Radius : to the sine $\angle$ included : : half the product of the sides : the area. Radius $= 90$: sine $\angle$ A : : $\frac{AD \times DB}{2}$: area.

Rule 3. Or add together the three sides, and from the half sum substract each side separately; then multiply together the half sum and all the remainders, and the square root of the product is the area.

PROB. 5. *To find the area of a trapezoid.*

Rule. Multiply the half sum of the parallel sides by the perpendicular distance between them.

PROB. 6. *To find the area of a regular polygon.*

Rule. Multiply the perimeter into half the radius of the inscribed circle, and the product will be the area.

PROB. 7. *To measure the area of any rectilineal figure.*

Rule. Divide the figure into triangles or trapezoids, as may be found convenient, and calculate them by any of the preceding rules for the area.

3. PROBLEMS ON THE CIRCLE.

PROB. 1. *Given the diameter of a circle, to find the circumference.*

Rule. Multiply the diameter by the number 3.1416 for the area.

PROB. 2. *Given the circumference of a circle, to find the diameter.*

Rule. Divide the circumference by the common number 3.1416, and the product will be the diameter.

PROB. 3. *Given the diameter and circumference of a circle, to find the area.*

Rule. Multiply the circumference into half the radius, and it gives the area.

PROB. 4. *Given the diameter of a circle, to find the area.*

Rule. Multiply the square of the diameter by .7854, or multiply the square of the radius by 3.1416, for the area.

PROB. 5. *Given the circumference of a circle, to find the area.*

Rule. Multiply the square of the circumference by .0795775, and it will give the area.

PROB. 6. *To find the length of the arc of a circle.*

Rule. Find the length of the whole circumference, by Prob. 1; then say, as 360° are to the whole circumference, so is the number of degrees in the given arc to its length.

PROB. 7. *To find the area of a sector of a circle.*

Rule. Multiply the arc line into half the radius, and it will give the area.

Note. The above are the rules by which any superficies may be measured. The two first may be proved by measurement; and the whole of them are proved by geometry, algebra, and fluxions. The above rules cannot but be useful to all young persons of either sex; they are exceedingly plain, and easily to be comprehended, and may be successfully used by those who do not understand one proposition in geometry.

4. *Land Surveying.*

1. Land surveying is neither more nor less than the putting in practice the above rules for measuring figures, by applying them to fields and the surface of the earth.

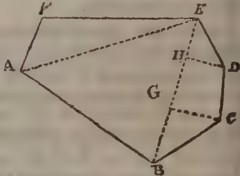
Observation. The Land Surveyor makes use of the *chain*, the *theodolite*, the *plain-table*, and the *mariner's compass*, for taking measures of length, angles, and finding the true position of fields, estates, &c.

The chain made of iron wire contains 100 links. But there are in this island two chains used; the Scots and the English. (*See Table page* 187.) Each of these, however, contains 100 links; but the Scots link measures 8.88 inches, while the English is only 7.92 inches. The Scots chain is consequently 74 feet, and the English 66.

5. *To survey a field by the chain.*

The sketch in the annexed diagram presents the field ABEF, divided by the line A E into two triangles, which is by far the most convenient method. We now, after tracing this line on the ground, measure the sides AB, B E, E F, F A, and A E, respectively. Then by *Rule* 3 *Prob.* 4 of Mensuration of Superficies, page 187, we find the area of each triangle, A B E, E F A; we add these together, and their sum is the area of the whole figure A B E F.

Suppose, further, the field was in the form A B C D E F; then we should reduce to triangles the portion B C E F, thus; on E B, let fall the perpendiculars C G, D H, join H C, or D G, and calculate as in the last case the area of each of the triangles B G C, G C H, H C D, D H E; add them to the area of ABEF, and the sum will be the area of the whole field A B C D E F; and in this way we survey fields.



6. *Mensuration of Solids.*

The mensuration of solid bodies is the finding how many cubical pieces of any dimension will be contained in any given figure. And all the practical rules for these are contained in the following problems.

Prob. 1. *To find the solidity of a cube.*

Rule. Cube the length of the lineal side, and it gives the solidity.

Prob. 2. *To find the solidity of a parallelopipedon.*

Rule. Multiply the area of the end by its length, and it gives the solidity.

Prob. 3. *To find the solidity of a prism.*

Rule. The same as in the last problem.

Prob. 4. *To find the solidity of a cylinder.*

Rule. The same as prob. 2.

Prob. 5. *To find the solidity of a pyramid.*

Rule. Multiply the area of the end into one third of its perpendicular altitude, and it gives the solidity.

Prob. 6. *To find the solidity of the frustum of a pyramid.*

Rule. Add together the area of the two ends, and the mean proportional between them, and multiply the sum by one third of the perpendicular altitude, for the solidity.

Prob. 7. *To find the solidity of a cone.*

Rule. Multiply the area of the end by one third of the perpendicular altitude for the solidity.

Prob. 8. *To find the solidity of the frustum of a cone.*

Rule. The same as prob. 6.

Prob. 9. *To find the surface of a sphere.*

Rule. Find the area of the circle whose diameter is equal to that of the sphere, and 4 times this area is the surface. Or, multiply the circumference by the diameter, for the surface of the sphere.

Prob. 10. *To find the solidity of a sphere.*

Rule. Multiply the cube of the diameter by the common number 5,236, and it gives the solidity.

PROB. 11. *To find the solidity of a polar segment of a sphere.*

Rule. From the triple product of the sphere into the square of the segment's height, subtract twice the cube of the height, and multiply the sum by 5,236, and it gives the solidity.

PROB. 12. *To find the solidity of a spheroid.*

Rule. Multiply the fixed axis by the square of the revolving axis, and the product by 5,236, gives the solidity.

PROB. 13. *To find the solidity of the middle section of a spheroid; made by planes cutting it at equal distances from the centre perpendicular to the axis.*

Rule. To the area of the end, add twice the area of the middle section, then multiply the sum by the length, and $\frac{1}{3}$ of the product gives the solidity.

PROB. 14. *To find the solidity of a paraboloid or parabolic conoid.*

Rule. Multiply the area of the end by $\frac{1}{2}$ the altitude.

PROB. 15. *To find the solidity of a frustum of a paraboloid.*

Rule. Multiply the sum of the areas of the two ends by half the perpendicular distance between them.

PROB. 16. *To find the solidity of a parabolic spindle.*

Rule. Multiply the area of the greatest circle, or middle section, by the length, and 8-15ths of the product gives the solidity.

PROB. 17. *To find the solidity of the middle frustum of a parabolic spindle.*

Add together 8 times the square of the diameter of the greater end, 3 times the square of the diameter of the less end, and 4 times the product of the diameters; multiply the sum by the length of the frustum, and the product by .05236, or of $\frac{1}{15}$ .7854 for the solidity.

PROB. 18. *To find the solidity of any solid body.*

Rule i. Multiply the tabular area by the square of the given side for the surface.

Rule ii. Multiply the tabular solidity by the cube of the given side for the solidity.

Surfaces and Solidities of Regular Bodies:

Number of sides.	Name.	Surface when the side is 1.	Solidity when the side is 1.
4	Tetraedron	1.7320508	0.1178511
6	Hexaedron	6.	1.
8	Octaedron	3.4641016	0.4714045
12	Dodecaedron	20.6457788	7.6631189
20	Icosaedron	8.6602540	2.1816950

Note. On this Chapter of Practical Mathematics, we have omitted to put questions, for the same reason which we assigned for a similar omission under the article Geometry.

CHAPTER XV.

ALGEBRA.

1. ALGEBRA is the science of *Analysis*. Algebra reasons upon quantity by *symbols*, and examines, in general, all the different methods and cases that exist in the doctrine and calculation of numbers.

2. The *symbols* or characters adopted are the letters of the alphabet, which we call *algebraic quantities*; as a, b, c, &c.

Observation. (1.) These letters stand for *numbers*, and can therefore be applied to any thing to which numbers can be applied.

(2.) They differ from figures, because *each* figure expresses a *determinate* number, but *each* of the letters stands for *any* number whatever, and, consequently, any thing which can be proved respecting *any* of the letters or symbols is applicable to *any* number whatever.

3. The sign + (plus) is employed to connect, or add one quantity with another: it is therefore the symbol or sign of *Addition*.

4. The sign — (minus) indicates that the number before which it is placed is to be taken from the number which precedes the symbol. It is, therefore, the sign of *Subtraction*.

Illustration. Thus, $a + b$ shows that the number represented by b is to be added to that represented by a.

$a - b$ shows that the number represented by b is to be subtracted from that represented by a.

When the quantities are all positive or all negative they are said to be *like;* when they are some positive and some negative, they are said to be *unlike:*

Observation. The axioms of Geometry apply to several branches of Algebra, and are usually studied in connection with these definitions.

The co-efficients are the numbers prefixed to algebraic quantities; as, $2a$, *twice* a.

$\times$ is the sign of Multiplication, $\div$ is the sign of division, $: \,::\, :$ is the sign of proportion:

Addition.

5. From the two-fold division of Algebraic quantities into *positive* and *negative, like* and *unlike,* there arise *three* cases of Addition, of which,

Case I. Instructs us *To add like quantities with like signs.*

Rule. Add all the *co-efficients,* annex the *common letter,* or letters, and prefix the *common sign.*

Note. When a leading quantity has no sign prefixed to it, the sign $+$ (plus) is always understood; and a quantity without any co-efficient is supposed to have 1 or unity before it. Thus $a =$ once a $(1a)$.

Examples.

1.	2.
$12a$	$6a + 9x - b$
$2a$	$5a + 5x - 6b$
a	$a + x - b$
$15a$	$15a + 24x - 8b$

Case II. To add like quantities with unlike signs.

6. *Rule* 1. Collect the *positive* co-efficients into one sum, and the *negative* ones into another.

2. From the *greater* of these sums subtract the *less*, and to the remainder prefix the *sign of the greater*, and annex the *common letters*.

Observation. If the aggregate of the positive terms be equal to that of the negative ones their sums will be $= 0$.

*Examples.**

1.	2.
$-3x+4$	$-7ab+3bc-xy$
$x-5$	$ab+2bc+4xy$
$-5x+1$	$3ab-bc+2xy$
$+2x-4$	$-2ab+4bc-3xy$
$-4x+13$	$5ab-8bc+xy$
$-9x+9$	$-2ab$ * $+3xy$

* *Illustration.* 1. Euler observes that the manner in which we generally calculate a person's property is an apt illustration of the foregoing rule. We denote what a man's real property is, by *positive* numbers, using the sign $+$, whereas we represent his debts by *negative* numbers, or by understanding the sign $-$, as affecting those numbers.

2. Thus, when it is said of any one that he has 100 crowns, but owes 50, this means that his real possession amounts to $100-50$, or which is the same thing $+100-50$; that is to say, 50. And if he has in possession 20 crowns, but owes 20, his real possession amounts to $20-20$, or $+20-20, = 0$. In a word, he has nothing; but then he owes nothing.

3. But, on the other hand, if he owes 70 crowns and has in possession only 40, his real possession would be expressed thus $-70+40$. Here his debt is fairly represented by the negative number -70, while his real pos-

session is represented by the positive number + 40. It is certain, therefore, that he has 30 crowns *less* than nothing: and we might, consequently, express the state of his finances thus — 30; for if any one were to make him a present of 30 crowns to pay this debt or — 30, he would only be at the point (0), though really richer than before.

4. Debts, or sums of money owing, are therefore as much *real* sums, or quantities of money, or real numbers, as credits are; and the sign +, or —, *governs* the quantity or number that follows it.

Case III. To add unlike quantities.

7. *Rule.* Collect all the like quantities, by the last rules, and set down those which are *unlike*, one after another, with their *proper* signs.

Examples.

1.

$$\begin{array}{rr} 2xy & -\ 10x^2 \\ -3x^2 & +\ xy \\ -8x^2 & -\ xy \\ -xy & +\ 9x^2 \\ \hline xy & -\ 12x^2 \end{array}$$

2.

$$\begin{array}{lrrr} 3ab & +\ x^2 & -\ y^2 \\ 4c & +\ 2y & -\ x^2 \\ 5ab & -\ 3c & +\ d \\ 4y & +\ x^2 & -\ 2y \\ \hline \multicolumn{3}{l}{8ab - c + d + 2x^2 + 3y} \end{array}$$

SUBTRACTION.

8. *Rule* 1. Write in one line those quantities from which the subtraction is to be made, and which we call the *minuend*; then underneath write all the quantities to be subtracted, which we call the *subtrahend*, ranging under each other the *quantities of the same denomination.*

2. *Change* the signs of the quantities to be subtracted, or conceive them changed; then collect the different terms, and place them as directed by the rules of Addition.

Illustration. This rule may be thus illustrated. If it were required to subtract $5 - 2$ (i. e. 3) from 9, it is evident that the remainder would be *greater* by 2 than if 5 *only* were subtracted. For the same reason, if $b - c$ were subtracted from a, the remainder would be greater by c than if b only were taken away. Now if $+ b$ be subtracted from $+ a$, the remainder will be $a - b$; and consequently if $b - c$ be subtracted from a, the remainder will be $a - b \quad c$. If b were a negative quantity $(-b)$ to be taken from $+ a$ (or a), we should obtain $a + b$. For the same reason when c is a negative quantity $(-c)$ and b a positive one, as in the expression just given, we change the sign of both, thus; $-b \times c$, when we would take them from a.

Examples.

1.	2.
$a + b$	$6x^2 - 8y + 3$,
$-b$	$2x^2 \times 9y - 2$
$* \; 2b$	$4x^2 - 17y + 5$

MULTIPLICATION.

9. In the *multiplication* of Algebraic quantities, *four* circumstances are to be considered:

1. The *signs* of the quantities;
2. Their *co-efficients;*
3. The *letters* of which they are composed; and
4. The *indices* or *exponents* of those letters.

10. In performing any operation in multiplication, we must, therefore, observe the *four* following rules:—

1. When quantities having *like* signs are multiplied together, the product will be + (plus). On the contrary, if their signs are *unlike*, the sign of the product will be — (minus).

2. That the *co-efficients of the factors* must be *multiplied* together to form the co-efficient of the product.

3. That the *letters* of which the factors are composed must be set down, one after another, according to their order in the alphabet.

4. That, if the same letter be found in both facters, the indices of this letter must be added, to form its index in the product.

Note. In a^2 the figure 2 on the right hand corner of the letter is the index.

11. From these four rules we have these four general expressions.

1. As to their signs	$+a \times +b = +ab$
2. —— signs and co-efficients	$+2 \times -3 = -6$
3. Signs, co-efficients and letters	$-3ab \times +5cd = -15abcd$
4. Signs, co-efficients, letters and indices	$-4a^2b^2 \times -3abd^3 = +12a^3b^3d^3$

12. That like signs make plus(+)and unlike signs minus(—)in the product may be illustrated thus:

First. When $+a$ is to be multiplied by $+b$ this denotes that $+a$ is to be taken as many times as there are units in b, and because the sum of any number of affirmative terms is affirmative, it is obvious that $+a \times +b = +ab$.

Secondly.—If two quantities are to be multiplied together, the result will be actually the same, in whatever order they are placed; for a times b is the same as b times a; and therefore when $-a$ is to be multiplied

by $+ b$, or $+ b$ by $- a$ it is the same thing as taking $- a$ as many times as there are units in $+ b$; and as the sum of any number of negative terms is negative, it is plain that $- a \times + b$, or $+ b \times - a = - ab$.

Lastly. When $- a$ is to be multiplied by $- b$, we have ab for the product at first sight, but still we must determine whether the sign $+$ or $-$ is to be placed before the product. Now it cannot be the sign $-$, for $+ \times -$, or which is the same thing $+ a \times - b$ gives $- ab$, and $- a \times - b$ cannot produce the same result as $- a \times + b$; but must produce a contrary result, to wit, $+ ab$ consequently we have the following rule: — $-$ multiplied by $-$ produces $+$, in the same manner as $+ \times +$ gives $+$

But this illustration may be demonstrated thus:

When the compound quantitity $+ a - b$ is to be multiplied by $+ c$ we repeat or add $+ a - b$ to itself as often as these are units in c; hence, since the sum of any number of affirmative terms is affirmative, and the sum of any number of negative terms is negative, it is obvious, that $+ a - b$ multiplied by $+ c$ produces $+ ac - bc$; for the same reason $+ a - b$ multiplied by $+ d$ produces $+ ad - bd$.

Whence, if from c times $(a - b) = + ac - bc$
we subtract d times $(a - b = + ad - bd$
The remainder will be $(c - d$ times $a - b) = + ac - bc - ad + ad$.

Wherefore $\begin{cases} + a \times + c = + ac \\ - b \times - d = + bd \end{cases}$ like signs produce *plus*.

And . . . $\begin{cases} - b \times + c = - bc \\ + \times - d = - ad \end{cases}$ unlike signs produce *minus*.

13. From the division of algebraic quantities into *simple* and *compound* three cases of multiplication arise, and in performing the operation in all these cases, we must attend *first* to the signs, *then* the co-efficients, and *lastly* the letters and indices.

Case I. When both factors are simple quantities.

14. *Rule.* Attend to the signs, co-efficients, and indices, by the foregoing Rules (Articles 10 and 11).

Examples.

1.	2.	3.	4.
$12a$	$-2a$	$-6ax^2$	$+7xy^2$
$4b$	$+4b$	$5ax^2$	$+5ax$
$48ab$	$-8ab$	$30ax^4$	$35ax^2y^2$

Case II. When one factor is compound and the other simple.

15. *Rule.* Multiply each term of the compound factor by the simple factor, as in the last case, and the result will be the product required.

Examples.

1.	2.
$3ab-2ac+d$	$3x^3-2x^2+4$
$4a$	$-12ax$
$12a^2b-8a^2c+4ad$	$-36ax^4+24ax^3-48ax$

Case III. When both factors are compound quantities.

16. *Rule.* Multiply *each* term of the multiplicand by *each* term of the multiplier: and hen, placing *like quantities* under each other,

the sum of all the terms will be the product required.

Examples.

1.

$$\begin{array}{r} a + b \\ a + b \\ \hline a^2 + ab \\ ab + b^2 \\ \hline a^2 + 2ab + b^2 \end{array}$$

2.

$$\begin{array}{r} a + b \\ a - b \\ \hline a^2 + ab \\ - ab - b^2 \\ \hline a^2 \quad * \quad - b^2 \end{array}$$

DIVISION.

17. The same circumstances are to be taken into consideration, in the division of algebraic quantities, as their multiplication embraced, and consequently we must attend to the four following rules.

1. If the signs of the *dividend* and *divisor* be *like*, the sign of the quotient will be +; but if *unlike*, the sign of the quotient will be —.

2. That the *co-efficient of the dividend* is to be divided by the *co-efficient of the divisor*, to obtain the co-efficient of the quotient.

3. That all the letters common to both the dividend and divisor must be *rejected* in the quotient.

4. That, if the *same* letter be found in both the dividend and divisor, with *different* indices, then the index of that letter in the divisor, must be subtracted from its index in the dividend, to obtain its index in the quotient.

18. From these rules we derive the four following expressions :—

1st. $+abc$ divided by $+ac$, or $\dfrac{+abc}{+} = +b$

2nd. $+6abc$ by $-2a$, or $\dfrac{6abc}{-2a} = -3bc$

3d. $-10xyz$ by $+5yz$ or $\dfrac{-10xyz}{+5y} = -2xz$

4th. $-20a^2x^2y^3$ by $-4axy$, or $\dfrac{-20a^2x^2y^3}{-4axy} = +5axy^2$

Note.—Of Division, also, there are *three* cases, as in Multiplication.

Case I. When the dividend and divisor are both simple terms.

19. *Rule.* Divide the *co-efficient* of the *numerator* by the *co-efficient* of the *denominator*, expunge those letters which are common to both terms of the fraction, and annex the odd ones, if any, to the numeral quotient.

Examples.

1. $\dfrac{18ax^2}{3ax} = 6x$ ANS.

2. $\dfrac{+15a^2b^2}{-5a} = -3ab^2$ ANS.

Case II. When the dividend is a compound quantity and the divisor a simple one.

20. *Rule.* Divide each term of the dividend separately by the *simple* divisor, and the resulting quantities will be the quotient required. (*Art.* 18.)

Example.

Divide $42a^2 + 3ab + 12a^2$ by $3a$ +

Here $\dfrac{42a^2 + 3ab + 12a^2}{3a} = 14a \times b + 4a$ ANS.

Case III. When the dividend and divisor are both compound quantities.

21. *Rule* 1. Arrange both dividend and divisor according to the *powers* of the same letter, beginning with the *highest*.

2. Then find how often the *first* term of the *divisor* is contained in the *first* term of the *dividend*, and place the result in the quotient.

3. Multiply each term of the *divisor* by this quantity, and place the product, under the corresponding (i. e. *like*) terms in the *dividend*, and then subtract the one from the other.

4. To the remainder bring down as many terms of the *dividend* as will make its number of terms equal to the number of terms in the divisor; and then proceed as before, till the terms are all brought down as in common arithmetic.

Example.

Divide $a^3 - 3a^2b + 3ab^2 - b^3$ by $a - b$.

$$a - b\,)\,a^3 - 3a^2b + 3ab^2 - b^3\,(\,a^2 - 2ab + b^2)\ \text{Ans.}$$
$$a^3 - a^2b$$
$$* - 2a^2b + 3ab^2$$
$$- 2a^2b + 2ab^2$$
$$* \quad + ab^2 + b^3$$
$$+ ab^2 - b^3$$
$$* \quad *$$

Illustration. In this example, we arrange the dividend according to the powers (i. e. the index) of a the *first*

term of the divisor. Having done so, we proceed by the following steps:

1. a the first term of the divisor is contained in a^3, a^2 times; and this (a^2) is put in the quotient.

2. $a - b$ is multiplied by a^2, and it gives $a^3 - a^2b$.

3. From $a^3 - 3a^2b$ in the dividend we subtract the product of $(a - b)\, a^2$ or $a^3 - a^2b$, and the remainder is $-2a^2b$.

4. The next term $+ 3ab^2$ in the dividend is now brought down.

5. a the first term of the divisor is contained in $-2a^2b$, $-2ab$ times, which we put in the quotient.

6. *Multiply* and *subtract* as before, and the remainder is ab^2.

7. Bring down the last term of the dividend $-b^3$.

8. a the first term of the divisor is contained in ab^2, $+b^2$ times; put this in the quotient.

9. *Multiply* and *subtract* as before and nothing remains. The quotient therefore is $a^2 - 2ab + b^2$, and we call it the answer.

10. To prove the operation, multiply the quotient $a^2 - 2\, ab^2 + b^2$ by the divisor $a - b$, and the product will be the dividend; for by the nature of division it is evident, that if one number be divisible by another, the quotient multiplied by the divisor will produce the dividend. Whence the reason of the above rules (Art. 17) and operations is evident from what was proved in Multiplication, (See Art. 9 and 10).

Of Algebraic Equations.

22. The principal object of Algebra, as well as of all the parts of the mathematics, is to determine the value of quantities which were before *unknown*. This is obtained by considering attentively the conditions given, which are always expressed in *known* numbers.

Illustration. When we have a question to resolve, we represent the number sought by one of the last letters of the alphabet, and then consider in what manner the given conditions can form an *equality* between the two quantities. This *equality* is represented by a kind of *formula* called an EQUATION as $a + b = x$, and it enables us at last to determine the value of the number sought, and consequently to resolve the question. Sometimes, several numbers are sought; but they are found in the same manner by equations.

23. Let us endeavour to explain this further by an example, which we shall call a Problem.

PROBLEM 1. Suppose $x+y=24$, and $x-y=16$, to find the value of x and y, we proceed thus:

$$\begin{array}{rl} \text{Here } x + y & = 24 \\ x - y & = 16 \\ \hline 2x & = 40 \\ \text{therefore } x & = 20 \\ \text{and } y = 20 - 16 & = 4 \end{array}$$

For here $+ y$ destroys $- y$; and when we add the like quantities $x + x = 2x$, and $24 + 16 = 40$. Now $x = 40 \div 2 = 20$, and consequently $y = 20 - 16 = 4$.

PROB. 2. To divide 7 into two such parts, that the greater part may exceed the less by 3; we proceed thus:

Let $x =$ the greater part
And $7 - x =$ the less
So that $- x = 7 x + 3$
Or $x = 10 - x$
Adding x we have $2x = 10$
Therefore $x = 10 \div 2 = 5$ the greater part
Now since 5 exceeds 3 by 2, the less part is therefore 2; and as $5 + 2 = 7$, we know, by this proof, that the operation is right.

PROB. 3. A father, who has three sons, leaves them £1600. His Will specifies that

the eldest shall have £200 more than the second, and the second £100 more than the youngest. What then is the share of each out of the £1600 ?

Let x = the share of the youngest son.
then $x + 100$ = that of the second.
and $x + 300$ = that of the third.

Now the three shares together make £1600.
We have therefore $3x + 400 =$ £1600.

$3x =$ £1200.
and $x =$ £ 400.

Hence the share of the youngest is £400 ; that of the second £500; and that of the eldest £700.

Questions for Examination.

1. Of what is algebra the science ?

2. What are its symbols ? what do they express ?

3, 4. Define the nature and use of the signs + and —; and explain the signs × ; ÷ ; : :: : ; and .

5. How many cases of Addition are there ; and what is the nature of Case I. ; its rule and application ?

6. Also the nature of Case II. ; its rule and application ?

7. Likewise Case III.; its rule and application ?

8. Define the nature and show the application of Subtraction.

9. What four circumstances are to be considered in the Multiplication of algebraic quantities ?

10. What four rules must we observe in performing any operation in Multiplication ?

11. What four general expressions have we from these four rules ?

12. How do you illustrate that like signs make + (*plus*) and unlike signs make — (*minus*) in the product ?

13. What number of cases are there in Multiplication ?

14. What are the nature and application of Case I?
15. Also of Case II.?
16. Likewise of Case III.?
17. Define Division and the rules to which we must attend in performing divisional operations.
18. What four general expressions do we derive from the four rules you have just defined?
19. What are the nature and application of Case I. in Division?
20. Also of Case II.?
21. Likewise of Case III.?
22. Define Equations; and illustrate your definition by a formula or equation.
23. Explain this further from the Problems, 1, 2 and 3, in the text.

Of Fluxions.

1. Fluxion, in Mathematics, denotes the *velocity* by which *variable* or flowing quantities increase or decrease.

Observation. The whole doctrine of fluxions consists in solving the two following problems.

2. Prob. 1. From the fluent or variable flowing quantity given to find the fluxion, which constitutes what is called the direct method of fluxions.

3. Prob. 2. From the fluxion given to find the fluent, or flowing quantity; which makes the inverse method of fluxions.

Observation. In order to show the usefulness of fluxions we shall give one example.

4. *Example.* Thus, suppose it were required to divide a given right line AB into two such parts

A c, c B, that their products or rectangles may be the greatest possible. A——c——B

Let A B $= a$; and let the part Ac, considered as variable (by the motion of c towards B) be denoted by x.

Then B c being $= a - x$,
we have A c $\times$ B c $= ax - x^2$ whose fluxion
$ax - 2x^2$ being put $= 0$,
we get $ax = 2x^2$;
and consequently, $x = \frac{1}{2} a$

Hence, it appears, that A c (or x) must be exactly one half of A B, that its product or rectangle may be the greatest possible.

Questions for Examination.

1. What are Fluxions?
2. What are the conditions of the first problem on which the doctrine of fluxions is founded?
3. What also are the conditions of the second problem?
4. Give me an example of Fluxions with its solution.

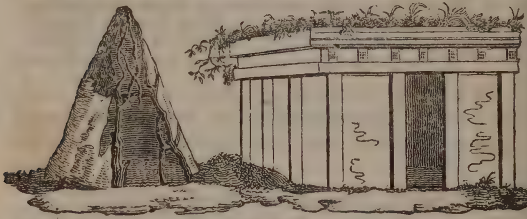
CHAPTER XVI.

ARCHITECTURE.

1. ARCHITECTURE is the art of building, or the science which teaches how to erect buildings, either for habitation or defence.

Observation. The origin of this noble art may be traced in the Indian's hut and the Greenlander's cave; which show the rude beginnings from which Architecture has grown to its present perfection and magnificence.

Architecture is an art of the first necessity, and almost coeval with the human species. Man, from seeking shade and shelter under the trees of the forest



soon felt the necessity and saw the utility of bending, them to more commodious forms than those in which he found them disposed by nature. And to huts made of trees and branches leaning together at top, and forming a conical figure plaistered with mud, succeeded, in process of time, more convenient square-roofed habi-

tations. Such may be considered the origin of regular building; but we proceed from vain speculation to

The five Orders of Architecture.

2. The ORDERS among ancient and modern architects are five; namely, the *Tuscan*, the *Doric*, the *Ionic*, the *Corinthian*, and the *Composite*, which are distinguished from each other by the column with its base and capital, and by the entablature. *(See Plate.)*

Illustration. 1. The TUSCAN order originated in Tuscany, and is characterised by its plain and robust appearance; it is therefore used only in works where strength and plainness are wanted; and it has been used, with great effect and elegance, in that durable monument of ancient grandeur, the *Trajan column* at Rome. Indeed general consent has established its proportions for purposes of strength beyond all others, and its strong and massy proportions have obtained for it the name of the *Rustic order*.

2. The DORIC, from Doria, a nation of ancient Achaia, possesses nearly the same character for strength, as the Tuscan, but is enlivened by its peculiar ornaments; the *triglyph*, *mutule*, and *guttæ* or drops, under the triglyph. These decorations characterise the Doric order, and in part are inseparable from it: and its proportions recommend it where united strength and grandeur are wanted: it has hence been called the *Herculean* order.

3. The IONIC, from Ionia, a district of Greece, partakes of more delicacy than either of the former. It is therefore called the *feminine order*, and not improperly supposed to have a matronlike appearance. It is a medium between the masculine Tuscan and the Doric, and the virginal slenderness of the Corinthian. The boldness of the capital, with the beauty of the shaft, makes it eligible for porticos, frontispieces, entrances to houses, &c. *Dentiles* were first added to the cornice of this order.

4. The CORINTHIAN, from Corinth, a city of Greece, possesses more delicacy and ornament, than any other order; the beauty and richness of the capital, and the delicacy of the pillar, render it the most suitable in those edifices, where magnificence and elegance are required. On this account, it is frequently used for the internal decoration of large state rooms, in which it has a chaste and superb appearance.

The annexed diagram offers a very just view of the origin of the Corinthian capital, which was suggested to Callimachus, a sculptor, by the following circumstance: a basket had been set upon the ground and covered with a square tile; near to it grew a plant of acanthus or bear's breech; the leaves shot up and covered the outer surface of

the basket; and as the stalks rose up among them, they soon reached the tile which overhung the edges of the basket at the top; this stopping their course upwards they curled and twisted themselves into volutes; and thus the artist saw how, by raising the volutes of the Ionic order among acanthus leaves, a noble and lofty capital might be formed.

5. The COMPOSITE, or Roman order, is the same as the Corinthian, in its proportions, and nearly alike in ornamental properties. The addition of the modern Ionic volute to the capital gives a bolder projection. It is applicable in the same cases as the Corinthian.

Observation. (1.) Among the innumerable monuments of architecture constructed by the Romans, how many have escaped the notice of history, how few have resisted the ravages of time and barbarism! And yet even the majestic ruins, still scattered over Italy and the provinces, would be sufficient to prove, that those countries were once the seat of a polite and powerful empire; but they are rendered more interesting, by two important circumstances, which connect the history of the arts, with the history of human manners. Many

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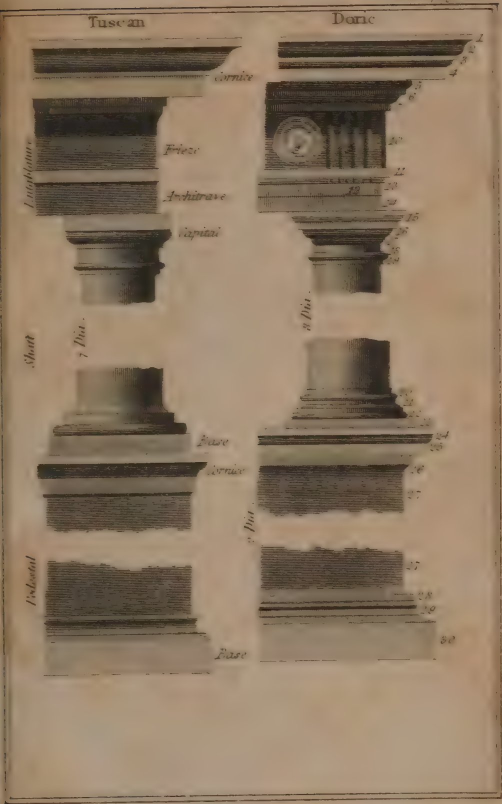

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of those works were erected at private expense, and almost all were intended for public benefit.

(2.) In the commonwealth of Athens and Rome, the modest simplicity of private houses announced the condition of freedom; whilst the dignity of the people was represented in the majestic edifices destined to the public use; nor was this spirit totally extinguished by the introduction of wealth and monarchy. It was in works of national honor and benefit, that the most virtuous of the emperors affected to display their magnificence. The golden palace of Nero excited a just indignation; but the vast extent of ground, which had been usurped by his selfish luxury, was more nobly filled, under the succeeding reigns, by the Coliseum, the baths of Titus, the Claudian portico, and the temples dedicated to the goddess of peace, and the genius of Rome. These monuments of architecture were adorned with the most beautiful productions of Grecian painting and sculpture; and in the temple of peace, a very curious library was open for the inspection of the learned.

(3.) At a small distance from thence was situated the forum of Trajan, surrounded with a lofty portico, in the form of a quadrangle. Four triumphal arches formed a noble and spacious entrance. In the centre arose a column of marble, whose height (one hundred and ten feet) denoted the elevation of the hill that had been cut away. This column, which still exists in its ancient beauty, exhibited an exact representation of the Dacian victories of its founder. The veteran soldier contemplated the story of his own campaigns; and, by an easy illusion of national vanity, the peaceful citizen associated himself with the honors of the triumph.

(4.) All the other quarters of the capital, and all the provinces of the empire, were embellished by the same liberal spirit of public magnificence, and were filled with amphitheatres, theatres, temples, porticos, triumphal arches, baths, and aqueducts, all variously conducive to the health, the devotion, and the pleasures of the meanest citizen.

It is natural to suppose, that the greatest number, as well as the most considerable of the Roman edifices, were raised by the emperors, who possessed so unbounded a command both of men and money. Augustus was accustomed to boast, that he found his capital of brick, and that he had left it of marble. The strict economy of Vespasian was the source of his magnificence. The works of Trajan bear the stamp of his genius. The public monuments, with which Adrian adorned every province of the empire, were executed not only by his orders, but under his immediate inspection. He was an artist; and loved the arts, as they conduced to the glory of the monarch. They were encouraged by the Antonines, as they contributed to the happiness of the people.

Modern Architecture.

3. On the decline of architecture among the Romans, and when the empire was entirely overrun by the *Goths*, the latter naturally introduced their own methods of building. But, like the ancient Egyptians, the Goths seem to have been more studious to amaze people with the greatness of their buildings, than to please the eye with the regularity of their plans, or the propriety of their ornaments. And those ancient buildings, in this island, which have gone under the indiscriminate denomination of *Gothic*, our modern antiquaries have, more accurately, divided into SAXON, NORMAN, and SARACENIC, or that species vulgarly, though improperly, called *Modern Gothic*.

Illustration. 1. The art of building edifices of stone

with windows of glass, and other ornaments, did not greatly florish for several centuries after the time of Benedict; so that, when Alfred the Great formed the design of rebuilding his ruined cities, churches, and monasteries, and of adorning his dominions with magnificent structures, he was obliged to invite artificers from foreign countries. Nor is it the least praise of this illustrious prince, that he was the greatest builder and the best architect of the age in which he lived. There is sufficient evidence, however, that, long after his time, almost all the houses in England, and the greatest part of the monasteries and churches, were very mean buildings, constructed of wood, and covered with thatch. The Anglo-Saxon nobility had no taste for magnificient buildings; but spent their great revenues in mean, low, and inconvenient houses. From the few remains of Saxon architecture in England, it appears to have been a rude imitation of the ancient Roman manner, and very different from that which is commonly called Gothic, of which so many noble specimens adorn our country. The most admired of the Saxon churches seem to have been low and gloomy, their pillars plain and clumsy, their walls immoderately thick, their windows few and small, with semicircular arches at the top.

2. What we commonly call Saxon is in reality Roman architecture, and this style of building was practised all over Europe, and continued to be used by the Normans, after their arrival here, till the introduction of what is called the *Modern Gothic*, which did not happen till about the end of the reign of Henry II. so that there seems to be little ground for a distinction between the Saxon and Norman architecture. The twelfth century, indeed, may very properly be called the age of architecture, in which the rage for building was more violent in England than at any other time. The religious of every order, enjoying peace and prosperity, displayed the most astonishing ardor in every thing that might

increase the splendor of divine worship. The ancient edifices, which had been raised in the days of Edgar and Edward the Confessor, were demolished, and others of greater magnificence were erected.

As William was sensible, that the want of fortified places in England had greatly facilitated his conquest, and might facilitate his expulsion, he built strong castles in all the towns within the royal demesnes. All his earls, barons, and even prelates, imitated his example; and it was the first care of every one who received the grant of an estate from the crown, to build a castle upon it for his defence and residence. William Rufus was still a greater builder than his father. "This prince," says an early writer, "was much addicted to building royal castles and palaces, as the castles of Dover, Windsor, Norwich, Exeter, the palace of Westminster, and many others, testify; nor was there any king of England before him, who erected so many, and such noble edifices."

Some of the most admired cathedrals in England, viz. those of York, Salisbury, and Winchester, are generally allowed to have produced the truest and fairest models of what is called the "*lighter Gothic style of building*." The steeples with spires and pinnacles, the pillars formed of an assemblage of columns, the lofty windows sometimes towering to a point, sometimes much enlarged, divided into several lights by stone mullions, and always filled with glass stained with lively colors, to represent the stories of saints and martyrs, stamp the sacred edifices of the thirteenth and fourteenth centuries.

Note. The following diagrams exhibit specimens of these styles of architecture.

Illustration 3. And this is in fact the *Saracenical* architecture, distinguished in every country by its numerous prominent buttresses, its lofty spires and pinnacles, its large and ramified windows, its ornamental niches and canopies, its sculptured saints, the delicate lace-work of its fretted roofs, and the profusion of ornaments indiscriminately lavished on every part of those buildings. But its most distinguishing characteristic is the small clustered pillars and pointed arches, formed by the segments of two intersecting circles; and these arches, though adopted last, are of a more simple and obvious construction than the semicircular ones.

4. There can be no doubt that the *Modern Gothic*, of Arabian extraction, was introduced into Europe by those who returned from the Crusades to the Holy Land.

There is a certain perfection in art to which human genius may aspire with success, and beyond which improvement degenerates into false taste and fantastic refinement. The rude simplicity of *Saxon architecture* was supplanted by the magnificence of the *ornamental* Gothic. But magnificence itself is at last exhausted, and it terminated, at length, in a style, which some, in allusion to literature, denominate the ***florid***. The superb chapel, which Henry VII. erected in Westminster, exhausted every ornament that taste could dictate, or piety accumulate, and exhibits a splendid specimen of Gothic architecture in its latest period. Grecian architecture

was then introduced; but its orders, till a purer taste prevailed, being intermixed with those of the Gothic, produced a discordant and barbarous assemblage.

The General Principles of Architecture.

4. *Of composition and harmony in buildings.* The original intention of architecture being protection from the inclemency of the weather, and this being easily attained by simple and coarse materials, carelessly compiled together, a considerable period must have elapsed before other objects were thought of as proper or necessary to be conjoined with it.

Observation. The experience of mankind, however, has long taught us, that architecture, though still chiefly valuable on account of its utility, is capable, as well as other arts and sciences, of exciting a variety of agreeable sensations, when in its execution, order, proportion, regularity, grandeur, and ornament are duly attended to. But as all these objects are not equally or uniformly requisite in all buildings, we must distinguish buildings and parts of buildings into three different kinds, *viz.*

I. Such as are intended solely for *utility;*

II. Such as are designed solely for *ornament;*

III. Such as are meant to comprehend both.

Illust. 1. *Buildings* intended solely for utility, ought in every part to correspond with that design; and any material deviation from usefulness, for the sake of ornament, ought to be strictly avoided.

Works of entire usefulness are considered as a mean to some end, and the nearer they approach to a perfect mean for obtaining that end, the more will such structures gain our applause, though every beauty of ornament be avoided.

2. On the other hand, in works merely calculated for ornament, such as columns, obelisks, triumphal arches, &c. beauty alone ought to be regarded. The principal difficulty in architecture lies in combining

usefulness and ornament. And the most practicable method is to prefer utility to ornament, in proportion as the character of the building requires it. In palaces and large buildings which admit of a variety of useful contrivance, regularity ought to be preferred; but in dwelling-houses, that are on too small a scale for variety of contrivance, regularity should give place to usefulness, so far at least as the former is inconsistent with the latter.

5. The *rules of building* require that, in every fabric, there should be *solidity, convenience,* and *beauty;* to which, according to some of the most refined masters, are added, *order, disposition, proportion, decorum,* and *economy.* These eight particulars are considered by the most skilful architects as absolutely requisite in the planning, erecting and finishing an entire fabric.

Illustration 1. *Solidity* implies the choice of a good foundation, and proper materials to work with.

2. *Convenience* demands such a disposition of the various parts of a structure that they may not crowd and embarrass each other, to appear disagreeable to the view of a spectator.

3. *Beauty* in visible objects is of two kinds;—the one *intrinsic*, because it is discovered in a single object, without relation to another;—the other *relative*, as it is founded on a combination of relative objects: and architecture admits of both these kinds of beauty.

There is a sort of beauty or harmony in the whole character of a building, with relation to its intended occupier, to which it is necessary to attend.

Thus, the appearance of a *Palace* ought to convey an idea of the majesty and grandeur of the monarch, so that a common observer may pronounce, on the first view of such an edifice, that it is destined to be the habitation of so dignified a personage.

A *Theatre* should have a gay and splendid style,

but that of a *Church* should be not only grave and solemn, but also bold and magnificent, affording a proper quantity and equal distribution of light to every part occupied during the time of worship.

The appearance and style of a *monument* ought to be solemn and gloomy, so ornamented as to awaken the memory or recollection of the deceased in the minds of his surviving friends.

Courts of justice, *senate*-houses, or the like, have also their proper style, which all good architects carefully observe.

4. *Order* gives each part of the building a proportionate extent; such as is adapted to the magnitude of the whole.

5. *Disposition* is the due arrangement and agreeable union of all the parts of the various apartments of the whole fabric.

6. *Proportion* is the relation that the whole work has to its constituent parts, and which each part has to the complete idea of the whole; for, in buildings that are perfect in their kind, from any particular part we may form an idea of the whole.

7. *Decorum* consists in making the whole aspect of the fabric so correct, that nothing shall appear, but what is founded in the principles of reason, geometry, and delicacy of judgment.

Observation. It includes design, or the choice of one situation in preference to another, which we may conceive improper for the kind of building we are about to construct; and directs us to pitch upon different prospects or views for different parts of an edifice.

8. *Economy* instructs the architect to have regard to the expense of his whole design, by a choice of such materials as are not only proper for his purpose, but the cheapest of the kind which he should use.

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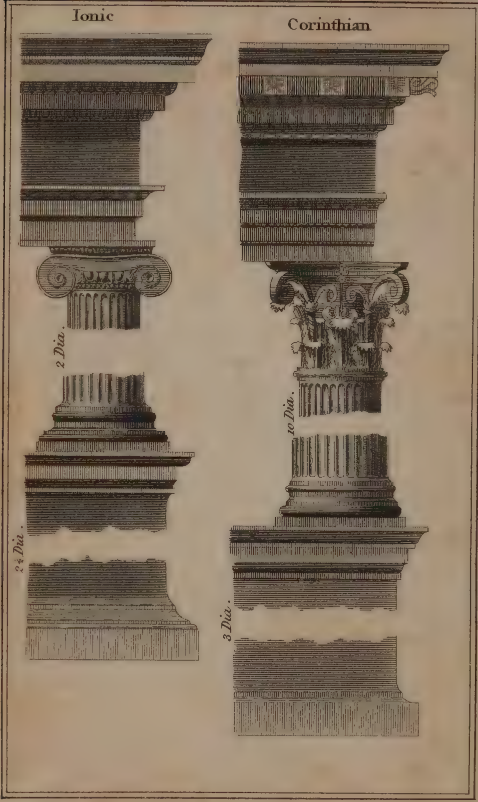

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The several Parts and Members of an entire Order.

6. The principal parts of an entire order are three: the *pedestal*, the *shaft*, and the *entablature*. And each of these is again subdivided into three smaller parts. Thus the PEDESTAL contains the *plinth*, the *dado*, and the *cornice*; the COLUMN includes the *base*, the *shaft*, and the *capital*; the ENTABLATURE consists of an *architrave*, a *frieze*, and a *cornice*.

Definitions. 1. The PLINTH takes its name from the Greek *plinthos*, a brick or flat square stone on which columns in the most early state of architecture are supposed to have stood.

2. The DADO, or DIE, is so called because it is of a cubic form.

3. The CORNICE is derived from *coronis*, a top or summit; because the cornice is the extreme end or finishing of the pedestal.

4. The BASE of the column is from *basis*, a foundation or footing for the column.

5. The SHAFT, that long and straight part of a column comprehended between the base and capital, is so named from the Greek *scapto* to dig, in the manner of a well, round and deep, whose inside resembles the shape of a pillar.

6. The CAPITAL, from the Greek *kephale*, or the Latin *caput*, the head, which the capital is of the column.

7. The ARCHITRAVE, from *archos*, chief or principal, and *trabs*, a beam, because the architrave is the chief support of the whole entablature.

8. The FRIEZE is so called from the Greek *phibron*, a border or fringe, which some of the ancients used to

call *zophoros*, because their friezes were usually enriched with the figures of animals.

9. The CORNICE of the *entablature*, or the crowning part of the entire order, is explained in def. 3rd.

7. These *nine* principal parts of a complete order, the dado and the shaft excepted, are composed of small members, which constitute all that simple and pleasing variety of mouldings which adorned the works of the ancients. The names of these mouldings allude to their forms, and their forms are adapted to the purposes for which they were intended. The names of the *members*, with their origin and use, are as follow, and the numeral figures refer to the parts numbered in the *Doric Order*. (*See the plate p.* 212.)

DEF. Fig. 1. The FILLET, from the French *fil*, a thread. *The references begin at the top of the figure.*

2. The CYMATIUM, or *cyma recta*, from the Greek *cumation*, a wave; because this member resembles the swelling and concavity of a wave.

3. The CYMA REVERSA, the preceding member inverted.

4. The CORONA, or crown, because it is the principal member of the cornice, and serves as a shelter to the smaller mouldings of the entablature.

5. The OVOLO, from *ovum*, an egg; because this member by the ancients was frequently carved in the form of an egg.

6. The CAVETTO, from *cavus*, hollow.

7. The CAPITAL, or upper fillet of the triglyph.

8. The TRIGLYPH, from the Greek *trigluphos, three engravings* compounded of *tri*, three, and *glupho*, to carve or engrave; in conformity to which, the triglyph has two entire channels and two half ones, with three spaces between.

9. The METOPE, from the Greek *metope*, the space between one aperture or hole and another; the triglyphs being supposed to be joists that fill the apertures; hence the space between the triglyphs, which forms an exact square, is called the *metope*.

10. The FRIEZE is explained in def. 8. p. 221.

11. The BAND is the same as the fillet.

12. The GUTTÆ, or the DROPS, are of a conical figure.

13. The ARCHITRAVE, explained in def. 7. p. 221.

14. The FACIA, or face; of these there are two in the architrave.

15. The ABACUS, from the greek *abax*, a shelf, or table, on which the ancient Mathematicians drew their geometrical schemes. The word seems to have been introduced from the invention of the Corinthian capital, which took its rise from an *acanthus* going round a basket.

16. The OVOLO of the capital is considered as the basket round which the acanthus grew.

17. The ANNULETS, so called because these fillets encompass the capital like rings joined to each other.

18. The COLORINO, the collar, or neck of the capital.

19. The ASTRAGAL, from the Greek *astragalos*, a bone of the heel; or the curvature of the heel, which this member resembles.

The hollow which follows is termed the ESCAPE, from the Greek *apophuge*, because this part of the column appears to fly off.

20. and 22. The upper and lower TORUS, from the Greek *Toris*, a cable, which this moulding somewhat resembles.

The SCOTIA, from the Greek *scotia*, darkness, because of the strong shadow which its concavity produces, and which is increased by the projecting torus above.

MUTULES or *modillions* are in some of the Doric entablatures placed perpendicularly over each triglyph, and are of the same width with it. In others are DENTILES, from *dentes*, teeth, which they resemble.

The capitals of the Ionic, Corinthian, and Composite orders are embellished by VOLUTES, so called from

volutum, a rolling round, as on a staff. Some people call the *volutes* the HORNS of the capital, because they resemble rams' horns.

23. The *Plinth;* 24. the *Cyma* inverted; 25. the *Facia;* 26. the *Hollow;* 27. the *Dado;* 28. the *Astragal;* 29. the *Cyma.*

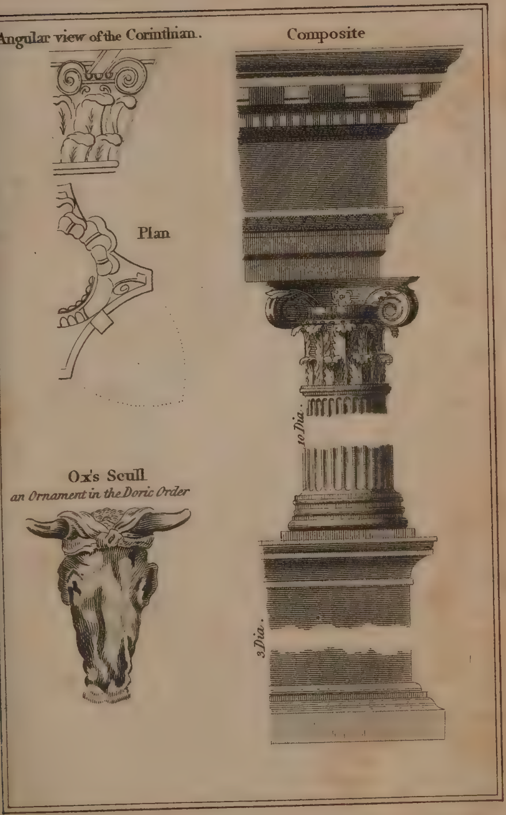
8. PILASTERS differ from columns only in their plan, which is a square, as that of columns is round. Their bases, capitals and entablatures, have the same parts, with the same heights and projections, as those of columns. They are also distinguished in the same manner, by the names of *Tuscan, Doric, Ionic, Corinthian, Composite.*

9. A COLONNADE is a series of columns disposed in a circle, wherein the columns are either placed close together, or insulated by a diameter and a half, or by two diameters of the column, and so on. And a *portico* is a continued range of pillars covered at the top. The portico of Palmyra was 4000 feet long.

10. ARCHES are used for triumphal entrances, gates of cities, &c.

Observation. Among the Romans, *triumphal arches* were erected in honor of illustrious generals, who had gained signal victories in war. They were at first built of brick or hewn stone, and of a semicircular figure. But when luxury introduced pomp and splendor, they were composed of the finest marble, and of a square figure, with a large arched gate in the middle, and two small arches on each side, adorned by columns and statues, and various figures in sculpture.

From the vault of the middle gate, were suspended little winged images of victory, with crowns which were



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put on the victor's head as they passed in triumph. This magnificence began under the first emperors.

Of Persians, Caryatides, and Termini.

11. Along with columns and pilasters, it is sometimes customary to employ representations of the human figure, to support entablatures in buildings. The *male* figures are called *Persians*, and the *female, Carians* or *Caryatides.*

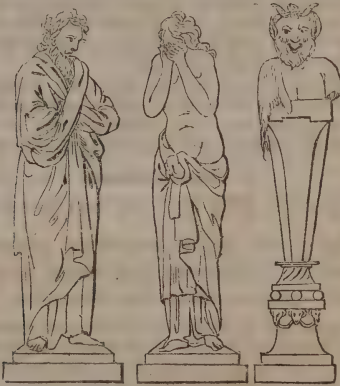


Illustration. 1. The Persians are so called from a victory gained over the Persians by *Pausanias*, who, having brought home some prisoners, spoils and trophies to the Athenians, they fixed upon Persian figures for those which should support entablatures, and thus kept in mind that they once had Persian slaves in Athens. To represent these conquered people in the lowest state possible, they loaded the sculptured figures with the Doric entablature, by far the heaviest of any of the

orders. In process of time, however, other figures besides those of Persians were introduced, and other entablatures put over them; but the name was still retained.

2. The proper CARYATIDES are women dressed in long robes, after the Asiatic style; and the origin of the device was as follows. The *Carians* had been long at war with the Athenians; but being at length totally vanquished, their wives were led away captives; and, to perpetuate the memory of this event, trophies were erected, in which figures of women dressed in the Caryatic fashion were used to support entablatures, like the male Persian figures; and though other female figures were afterwards used in the same manner, the name of *Caryatides* was always retained.

3. TERMINI (satyrs' heads, &c.) are sometimes employed to support the entablatures of monuments, chimney-pieces, and such-like compositions; as also for ornaments in gardens and pleasure grounds, fields, &c.

OF AQUATIC AND NAVAL ARCHITECTURE.

12. AQUATIC ARCHITECTURE considers the construction of wooden and stone *bridges*, of *aqueducts*, *quays*, *docks* for ships, &c.

Observation. The Romans were famous for their bridges. Thus the bridge of Trajan over the Danube was 1590 yards long, and its piers, which are still remaining, testify that there is nothing which human ingenuity is not able to effect.

There was a bridge at Nismes, in France, which supported an aqueduct consisting of three rows of arches, of which several still remain entire, and are reckoned among the most elegant monuments of Roman magnificence. The stones are of an extraordinary size, (some of them twenty feet long) and are said to have been joined together without cement, by ligaments of iron. The first row of arches was four hundred and thirty-eight

feet long; the second, seven hundred and forty-six; the third and highest, eight hundred and five; and the height of the three from the water, one hundred and eighty-two feet.

In the time of Trajan, a noble bridge was built over the Tagus, near Alcantara, in Spain, part of which may still be seen. It consisted of six arches, eight feet broad each, and some of them two hundred feet high above the water, extending in length six hundred and sixty feet.

An exceedingly large single-arched bridge is that over the river Elaver, in France. It is near the city Brioude, in Auvergne, and is called *Pons Brivatis*, from *Briva*, the name of a bridge among the ancient Gauls. The pillars stand on two rocks, at the distance of one hundred and ninety-five feet. The arch is eighty-four feet high from the surface of the water.

Of temporary bridges, the most famous was that of Cæsar over the Rhine, constructed of wood.

The Island of Britain presents some of the finest specimens of aquatic architecture, constructed of the most durable materials. Granite, in general, is the most durable of the productions of nature, and resists for the longest series of ages the destroying hand of time; as a building material, therefore, granite is unrivalled; and though in common cases its extreme hardness be against its employment, *Waterloo* Bridge, over the Thames at London, is mainly constructed of this material. The balustrades of this bridge are of Scottish, their base and coping of Cornwall granite; the fineness of the former to that of the latter, is thus strikingly contrasted.

And as a piece of aquatic architecture, the Breakwater, at Plymouth, about a mile in length, 100 yards wide at the base, and intended to be 10 wide at the top, above water, has already consumed 600,000 tons of a species of marble, which have been removed from the quarries at Oreston, and it is supposed that as much more will be required to complete this enormous barrier to the violence of the ocean. Many of the masses

of stone used in this undertaking weigh 10 tons; they are merely thrown upon one another, and the sea weeds gradually cement them.

13. NAVAL architecture is the art of ship-building, and requires, in designing the plan of a ship, great scientific knowledge, and practical skill.

Questions for Examination.

1. Define *architecture* and illustrate its progress.
2. Define each of the five *orders.*
3. What is said of *Modern* architecture?
4. What is understood of *composition* and *harmony* in buildings?
5. What do the *rules of building* require?
6. Illustrate each of the *three parts* of an entire order.
7. Describe each of the smaller *members.*
8. What are *pilasters?*
9. What are a *colonnade* and a *portico?*
10. What are arches, and their uses?
11. Describe separately the ornaments called *Persians*, *Caryatides*, and *Termini.*
12. What does *aquatic* architecture comprehend? Describe Bridges, &c.
13. What is naval architecture?

CHAPTER XVII.

Of Fortification and Gunnery.

1. Fortification is the science of military architecture, and when applied to a city, town, or other place, it consists in the art of putting any of these in such a posture of preparation, by means of ramparts, parapets, ditches, and outworks, that each individual part defends and is defended by some other parts, so that a small number of men can hold out for a considerable time against a great multitude.

2. The principle maxims of fortification are these:

1. That every part of the works be seen and defended by other parts, so that the enemy cannot lodge any where without being exposed to the fire of the place.

2. A fortress should command all places round it; and therefore all the out-works should be lower than the body of the place.

3. The works furthest from the centre should always be open to those that are nearer.

4. The defence of every part should always be within the reach of musket shot, that is, from 120 to 150 fathoms, or from 720 to 900 feet, so as to be defended both by ordnance and small fire arms; for, if it is only defended by cannon, the enemy may dismount them by the superiority of their own, and then the defence will be destroyed at once; whereas, when a work is likewise defended by small arms, if the one is destroyed, the other will still subsist.

5. All the defences should be as nearly direct as possible; for it has been found by experience, that the soldicrs are too apt to fire directly before them, without troubling themselves whether they do execution or not.

6. A fortification should be equally strong on all sides; otherwise the enemy will attack it in the weakest part, whereby its strength will become useless.

7. The more acute the angle at the centre is, the stronger will be the place.

8. In great places, dry ditches are preferable to those filled with water, because sallies, retreats, succours, &c. are necessary; but in small fortresses, wet ditches, that can be drained, are the best, as standing in need of no sallies.

3. Fortification is either *regular* or *irregular*. The REGULAR is that built in the form of a polygon, the sides and angles of which are all equal, being commonly about a musket shot from one another.

IRREGULAR fortification is that in which the sides and angles are not uniform, equidistant, or equal.

Observation. But the views of the engineer are not to be confined to the mere art of fortification; he must be able to take advantage of natural strength and position, of chains of mountains, and streams of water, together with the influence of climate, and whatever is applicable to his art.

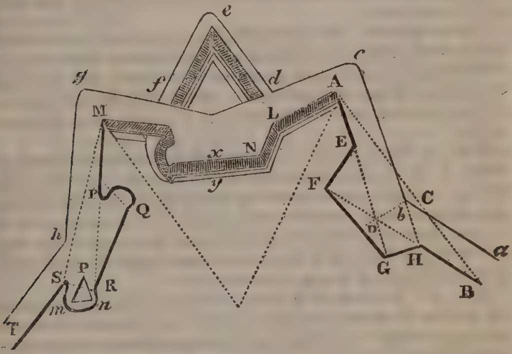
1. *Of Regular Fortification.*

Definitions. 1. The part F E A L N is called the *bastion*,

2. A E, A L, are the *faces* of the bastion,

3. E F, L N, the *flanks*,

4. F G, the *curtain*,
5. F N, the *gorge* of the bastion,
6. A G, B F, the *lines of defence*,
7. A B, the *exterior* side of the polygon,
8. C D, the *perpendicular*.



9. Any line which divides a work into two equal parts is called the *capital* of that work.
10. *a*, *b*, *c*, the *counterscarp* of the ditch.
11. A M, the *flanked* angles.
12. H, E, L, the *angles of the shoulder*, or *shoulder* only.
13. G, F, N, the *angles of the flank*.
14. Any angle whose point turns from the place is called *a salient angle*, as A M; and any angle whose point turns towards the place, a *re-entering angle*, as G, F, N.
15. If there be drawn two lines parallel to the principal or outline, the one at 3 toises distance, and the other at 8 from it, then the space *y x* included between the principal one, and that the farthest distant, is called the *rampart*.

Note. A toise is about 6½ English feet.

And the space x, contained by the principal line, and that near to it, and which in drawings is generally colored black, is called the *parapet*.

16. There is a fine line drawn within 4 feet of the parapet, which expresses a step called the *banquette*. In other words the banquette is a small bank at the foot of the parapet.

Observation 1. All works have a parapet of three toises thick, and a rampart of from 8 to 10 besides their slopes. The rampart is elevated more or less above the level of the place, from 10 to 20 feet, according to the nature of the ground, and the particular constructions of engineers.

Obs. 2. The parapet is a part of the rampart elevated from 6 to $7\frac{1}{2}$ feet above the rest, in order to cover the troops which are drawn up there from the fire of the enemy in a siege; and the banquette is two or three feet higher than the rampart, or about 4 feet lower than the parapet; so that when the troops stand upon it, they may just be able to fire over the parapet.

Def. 17. The *body* of a place is all that which is contained within the first rampart; for which reason it is often said *to construct the body of the place*, which means properly, *the construction of the bastions and curtains.*

18. All the works which are constructed beyond the ditch, before the body of the place, are called outworks.

5. PROBLEM. *To construct a regular fortification for the defence of a town.*

1. Inscribe in a circle a polygon of as many sides as the fortification is designed to have fronts.

2. Let A B (see the foregoing diagram) be one of the sides of half a hexagon, which bisect by the perpendicular C D.

3. Divide A C (the half of A B) into nine equal parts, and one of these into ten others; then these divisions will serve as a scale to construct all the other parts of the fortification, and each of them is supposed

to be a toise or fathom, that is, six French feet; and therefore the whole of A B is supposed to be 180 toises.

Note. As the dividing a line into so many equal parts is troublesome and tedious, it is more convenient to have a scale of equal parts, by which the works may be constructed.

4. If, therefore, in this case, the radius is taken equal to 180 toises, and the circle described with that radius being divided into six equal parts, or the radius carried six times round, you will have a hexagon inscribed.

5. A B being bisected by the perpendicular C D, as before, set off 30 toises from C to D, and draw the indefinite lines A D G, B D F, in which take the parts A E, B H, each equal to 50 toises.

6. From E as a centre describe an arc through the point H meeting A D in G, and from the centre H, describe an arc through the point E meeting B D in F; or, which is the same thing, make each of the lines E G, H F equal to the distance E H.

7. Then the lines joining the points A, E, F, G, H, B, will be the principal or outline of the front.

8. If the same construction be performed on the other sides of the polygon, you will have the principal or outline of the whole fortification.

9. If, with a radius of 20 toises, there be described circular arcs from the angular points B, A, M, T, and lines are drawn from the opposite angles E, H, &c. so as to touch these arcs, their parts *ab*, *bc*, &c. together with these arcs, will present the outline of the ditch. The student should now retrace all these lines from the definitions.

6. Fortifications consist of the following different sorts, of which the annexed table shows the measures, as they are forts, little fortifications, mean and great.

	Forts.						Little fortif.				Mean.		Great.	
Side of the Polygon.	80	90	100	110	120	130	140	150	160	170	180	190	200	260
Perpendicular.	10	11	$12\frac{1}{2}$	14	15	16	20	21	23	25	30	31	25	2
Faces of the Bastion.	22	25	28	30	33	35	40	42	45	47	50	53	55	60
Cap of the Raveline.	25	28	30	35	38	40	54	50	50	52	55	55	60	50

Illustration. 1. In the first vertical column are the numbers expressing the lengths of the exterior sides from 80 to 260; in the second, the perpendiculars answering to these sides; in the third, the lengths of the faces of the bastions; and, in the fourth, the lengths of the capitals of the ravelines.

2. The little fortification is chiefly designed for citadels of pentagonal construction; the perpendiculars are made one-seventh of the exterior side; the mean is used in all kinds of fortifications from an hexagon upwards to any number of sides; and the great is seldom used but in an irregular fortification where there are some sides that cannot be made less without much expense, or in a town which lies near a great river, where the side next the river is made from 200 to 260 toises; and as that side is less exposed to be attacked than any other, the perpendicular is made shorter, which saves much expense.

3. The faces of the bastions are all *two-sevenths* of the exterior sides, or nearly so, because the fractions are neglected.

4. It may be observed, in general, that in all squares the perpendicular is *one-eighth* of the exterior side, and all pentagons *one-seventh*, and in all the rest upward *one-sixth*.

2. *Of Irregular Fortification.*

7. The most essential principle in fortification consists in making all the fronts equally strong, so that the enemy may find no particular advantage in attacking either of the sides. But this can only occur in a regular work, situated in a plain or even ground; consequently there are but few places which are not irregular; and the great art here is, to remedy the defects and inconveniences occasioned by this circumstance.

Illustration. 1. If the situation to be fortified is an *old town*, inclosed by a wall or rampart, the engineer ought to consider well all the different circumstances of the figure, position, and nature of the ground, and to regulate his plan accordingly, so as to avoid as many disadvantages, on the one hand, and to obtain as many advantages, on the other, as possible. If there is a rampart without towers, it must be decided whether bastions ought to be added, and ravelines and counter-guards constructed. Special care must be taken to make all the sides of the polygon nearly equal, and that the length of the lines of defence do not exceed the reach of musket shot. Whenever the sides are inaccessible, either on account of a precipice, or marshy ground, they may be made much longer than those which are easy of access.

2. If the place to be fortified be *new*, and the situation will not admit of a regular construction, particular care must be taken to choose such a spot of ground as is most advantageous. All hills, or rising grounds should be avoided, as these might command some parts of the works; marshes, because such situations are unwholesome, and lakes and stagnant waters for the same reason, except they can be rendered navigable.

3. Places built on mountains or rocks should never be large, for their use is generally to guard passes, or inlets into a country, and it is difficult to provide for a large garrison under such circumstances. When fortifications are to to be placed in the neighbourhood of the sea, for the purpose of protecting trade, the first thing to be considered is their situation, which ought to afford a good harbour for shipping. When Vauban fortified near rivers, he always made the exterior side next to the water much longer than any of the others; for as that part is not so liable to be attacked, great and manifest advantages were of course derived from this circumstance.

8. **Problem.** To illustrate this method of M

Vauban, we shall give the plan of Huninguen, which was built for the sake of having a bridge over the Rhine, for which reason he made it only a pentagon; the side A B (see the plate) next to the river is 200 toises, and each of the others is but 180.

1. About the space *a b c*, which lies before the front A B, is a stone wall; and the passages are shut up with sluices, to retain the water in the ditches in dry seasons; and to prevent an enemy from destroying the sluice near the point *c*, whereby the water would run out and leave the ditches dry. The redoubt *y* was built in the little island hard by, in order to cover that sluice. Without this precaution the place might be assaulted from the river side, where the water is shallow in dry seasons.

2. The Horn-work K, beyond the Rhine, was built to cover the bridge; but as this work cannot be well defended across the river, the horn-work H was erected to support it.

3. Before finishing the description of this plan we shall show how to find the long side A B. After having described the two sides G E, G F, in a circle, draw the diameter C D, so as to be equally distant from the line joining the points E, F, that is, parallel to it. On this diameter set off 100 toises on each side of the centre; from these points draw two indefinite perpendiculars to the diameter; then if from the points E, F, as centres, two arcs be described with a radius of 180 toises, the intersections A and B, with the said perpendiculars, will determine the long side A B, as likewise the other two F B and E A.

In like manner may be formed the long or short side of any polygon whatever.

Observation. When a place near a river is to be fortified for the safety of commerce, particular care should be taken in leaving a good space between the houses

and the water-side, to have a quay or landing-place for goods brought by water; it should also be contrived to have proper places for ships and boats to lie secure in stormy weather, and in time of a siege; and as water-carriage is very advantageous for transporting goods from one place to another, as likewise for bringing the necessary materials, not only for building the fortifications, but also the place itself, the expenses will be lessened considerably when this convenience can be had. For these reasons places should never be built anywhere, but near rivers, lakes, or the sea, excepting in extraordinary cases, where it cannot be avoided.

3. *Of Field Fortification.*

9. *Field fortification* is the art of constructing all kinds of temporary works in the field, such as redoubts, field-forts, star-forts, triangular and square forts, heads of bridges, and various sorts of lines of defence, &c.

An army entrenched or fortified in the field, produces, in many respects, the same effect as a fortress; for it covers a country, supplies the want of numbers, stops a superior enemy, or at least obliges him to engage at a disadvantage.

Illustration. 1. The knowledge of the field engineer being founded on the principles of fortification, it must be allowed, that the art of fortifying is as necessary to an army in the field, as in fortified places; and though the maxims are nearly the same in both, yet the manner of applying and executing them with judgment, is very different.

2. The materials used in the field are such as can be readily obtained, *viz.* bags of sand, earth, and fascines ten feet long and one foot thick, which are fastened to

the parapet, by means of five pickets driven obliquely into the bank.

3. When wood cannot be obtained for the fascines, the parapet must be clothed with turf, four inches thick, and a foot and a half square.

4. The palisades for fortifying the ditch ought to be nine or ten feet long, and six inches thick.

5. The beams belonging to *chevaux-de-frize* should be twelve feet long, and six inches broad ; the spokes, seven feet long, four inches thick, and six inches distant from each other.

6. Gabions must be four feet high, and two or three feet in diameter.

Questions for Examination.

1. Define to me fortification.
2. Also each of its eight principal *maxims.**
3. Define *regular* and *irregular* fortification.
4. Draw the diagram, and go over the definitions of regular fortification.
5. Now, from the *problem,* construct a regular fortification for a town.
6. Repeat the measures of the side of the polygon, the perpendicular, the faces of the bastion, and the cap of the raveline, of forts, little, mean and great fortifications, and illustrate each column in the table.
7. What is to be observed in irregular fortification, as regards an old town, a new situation, places built on mountains or rocks, or near the sea?
8. From the problem, illustrate the fortification of Huninguen ; draw the diagram geometrically.
9. What rules are to be observed in field fortification?

* The tutor will of course ask the pupil the definition of these maxims one by one ; as also of such other questions as involve minute details.

4. *Of Gunnery.*

Definition. Gunnery is the art of charging, directing, and exploding fire arms, as cannon, mortars, muskets, &c. to the best advantage.

Practical Maxims of Gunnery.

1. In any piece of artillery whatever, the greater the quantity of powder it is charged with, the greater will be the velocity of the bullet.

2. If two pieces of the same bore, but of different lengths, are fired with the same charge of powder, the longer piece will impel the bullet with a greater celerity than the shorter.

3. If two pieces of artillery, different in weight, and formed of different metals, have yet their cylinders of equal bores and equal lengths; then with like charges of powder, and like bullets, they will each of them discharge their shot with nearly the same degree of celerity.

4. The ranges of pieces at a given elevation are no just measures of the velocity of the shot; for the same piece fired successively at an invariable elevation, with the powder, bullet, and every other circumstance, as nearly the same as possible, will yet range to very different distances.

5. The greatest part of that uncertainty in the ranges of pieces, which is described in the preceding maxim, can only arise from the resistance of the air.

6. The resistance of the air acts upon projectiles in a twofold manner; for it opposes their motion, and, by that means, continually diminishes their celerity; and it besides diverts them from the regular track they would otherwise follow; whence arise deviations and inflections of the shot.

7. All bodies thrown horizontally or obliquely into the

air have a curvilinear motion, and the path which they describe is the curve called a *parabola;* and the bodies thus thrown or put in motion are called *projectiles.*

8. That action of the air by which it retards the motion of projectiles is of immense force; and hence, as we have just shown, the motion of these resisted bodies is totally different from what it would otherwise be.

9. This retarding force of the air acts with different degrees of violence, according as the projectile moves with a greater or less velocity; and the resistances observe this law:

That to a velocity which is double another, the resistance within certain limits is fourfold; to a treble velocity ninefold, and so on.

10. But this proportion between the resistances to two different velocities, does not hold if one of the velocities be less than that of 1200 feet in a second, and the other greater. For in that case the resistance to the greater velocity is nearly three times as much as it would come out by a comparison with the smaller, according to the law explained in the last maxim.

11. To the extraordinary power exerted by the air it is owing that, when two pieces of different bores are discharged at the same elevation, the piece of the largest bore usually ranges farthest, provided they are both fired with fit bullets, and the customary allotment of powder.

12. The greatest part of military projectiles will at the time of their discharge acquire a whirling motion round their axis by rubbing against the inside of their respective pieces; and this whirling motion will cause them to strike the air very differently from what they would do, had they no other than a progressive motion. By this means it will happen, that the resistance of the air will not always be directly opposed to their flight; but will frequently act in a line oblique to their course, and will thereby force them to deviate from the regular track they would otherwise describe: and this is the true cause of the irregularities described in maxim 4.

13. From the sudden trebling the quantity of the air's resistance, when the projectile moves swifter than at the rate of 1200 feet in a second, (as has been explained in maxim 10,) it follows, that whatever be the regular range of a bullet discharged with this last-mentioned velocity, that range will be but little increased, how much soever the velocity of the bullet may be still further augmented by greater charges of powder.

14. If the same piece of cannon be successively fired at an invariable elevation, but with various charges of powder, the greatest charge being the whole weight of the bullet in powder, and the least not less than the fifth part of that weight; then, if the elevation be not less than eight or ten degrees, it will be found, that some of the ranges with the least charge will exceed some of those with the greatest.

15. If two pieces of cannon, of the same bore, but of different lengths, are successively fired at the same elevation with the same charge of powder; then it will frequently happen that some of the ranges with the shorter piece will exceed some of those with the longer.

16. In distant cannonadings, the advantages arising from long pieces and large charges of powder are but of little moment.

17. In firing against troops with grape shot, it will be found that charges of powder much less than those generally used, are the most advantageous.

18. The principal operations in which large charges of powder appear to be more efficacious than small ones, are the ruining of ramparts, the dismounting of batteries or battering in breach; for, in all these cases, if the object be but little removed from the piece, every increase of velocity will increase the penetration of the bullet.

19. Whatever operations are to be performed by artillery, the least charges of powder with which they can be affected are always to be preferred.

20. Hence, then, the proper charge of any piece of artillery is not that allotment of powder which will

communicate the greatest velocity to the bullet, nor is it to be determined by an invariable proportion of its weight to the weight of the ball; but, on the contrary, it is such a quantity of powder as will produce the least velocity for the purpose in hand; and, instead of bearing always a fixed ratio to the weight of the ball, it must be different according to the different business which is to be performed.

21. No field-piece ought at any time to be loaded with more than one-sixth, or at the utmost one-fifth of the weight of its bullet in powder, nor should the charge of any battering piece exceed one-third of the weight of its bullet.

Examples. 1. An 18 pounder, the diameter of whose shot is about 5 inches, when loaded with 2*lbs* of powder, will, at an elevation of $3° \ 30'$, range to the distance of 975 yards.

2. A 24 pounder fired with 12*lbs* of powder, when elevated at $7° \ 15'$, will range about 2500 yards or 1 mile 740 yards.

3. A mortar for sea-service, charged with 30*lbs* of powder, has sometimes thrown its shell of $12\frac{3}{4}$ inches diameter, and of 231*lbs* weight, to the distance of 5450 yards. This at an elevation of 45°.

4. A musket-bullet, fired from a piece of the standard dimensions with one-fifth of its weight in good powder acquires a velocity of nearly 900 feet in a second: that is, it makes an actual range of 1059 yards.

5. The same bullet, fired with its whole weight of powder, makes a range of 1396 yards, exceeding the former by 337 yards only.

Note. On these maxims and examples the tutor will frame his own questions for the pupils.

CHAPTER XVIII.

OF PERSPECTIVE.

1. *Definition.* PERSPECTIVE is the art of drawing upon a plane surface the outlines of objects, so as to give the same representation to the eye that the objects themselves do in nature.

1. *The principal terms used in Perspective.*

2. The *original object* is the object which is to be represented in perspective; it is the parent of the design.

Observation. Any plane figure may become an object, as may any of its parts, as a broken pillar, the ruins of a house; but we generally speak of objects as relating to entire figures represented as solids, or to as much rural or other scenery as may be embraced under an angle of sixty degrees, formed by two lines meeting at the eye.

3. *Original planes*, or *lines*, are the surfaces of the objects to be drawn, or any lines on those surfaces; or it means the surfaces on which these objects stand.

4. The *perspective plane* is the picture itself which is supposed to be a transparent plane, through which we view the objects that are represented on it.

5. *Visual rays* are the rays of light which proceed from every part of the original objects, through the perspective plane to the spectator's eye, which is fixed, or supposed immoveable.

6. The *point of sight* is the fixed point from which the spectator views the perspective plane.

7. *Vanishing points* are the points which are marked upon the picture, by supposing lines to be drawn from the spectator's eye parallel to any original lines, and produced till they touch the picture.

8. *Vanishing planes* are lines formed on the picture by the intersection of supposed planes proceeding from the eye of the spectator to the picture, parallel to any original planes.

9. The *Horizontal line*, is the vanishing line of the horizontal plane, and is produced in the same manner as any other vanishing line; *viz.* by passing a plane through the eye parallel to the horizontal plane.

10. The *centre of the picture* is the point on the perspective plane, where a line drawn from the eye perpendicular would cut it. Consequently it is the nearest point in the picture to the spectator.

11. *Distance of the picture* is the distance from the eye to the centre of the picture.

12. *Distance of a vanishing-point* is the distance from the vanishing point on the picture to the eye of the spectator.

13. *Ground plane* is the surface of the earth, or plane of the horizon, on which the picture is supposed to stand.

14. *Ground line* is the line formed by the intersection of the picture with the ground plane.

2. *Different Kinds of Perspective.*

15. PARALLEL *perspective* is where the picture is supposed to be so situated, as to be parallel to the side of the principal object in the picture, as a building, for instance; or the perspective representation of a street, wherein the

lines indicating the gable of one house are parallel, but those representing the roofs and base line of the houses terminate in a point, called the *centre of the picture.*

16. OBLIQUE *perspective* is when the plane of the picture is supposed to stand oblique to the sides of the objects represented, in which case the representations of the lines upon those sides will not be parallel among themselves; but will tend towards their vanishing point; as when in a picture we see both lines representing the roof and basement of a building, both sideways and gable-wise, terminating in two points.

17. *A bird's-eye view* is a view supposed to be taken in the air, looking down upon the object, and differs from the usual way of drawing perspective views, in supposing the horizontal line to be raised much higher.

3. *The Principles of Perspective Drawing.*

18. The farther any object is from the eye, the smaller is its representation upon the picture, or the smaller is the optic-angle under which it is viewed. This is easily shown, and forms the basis of perspective.

19. All lines parallel among themselves, but not to the picture, tend to a point in the picture.

20. All parallel lines have the same vanishing point.

21. The centre of the picture is the vanishing point of all lines perpendicular to the picture.

22. The representations of lines which are parallel to the picture have no vanishing point.

23. The perspective representations of circles are ellipses whenever the eye is without the circle.

24. The perspective of circles, as well as of other curves, is found by drawing round them reticulated squares, and then, having put these into perspective, tracing the curve through the same points in the perspective representation of the reticulation as it passes through the original.

Questions for Examination.

1, 2. Define perspective, and also the original object.

3, 4. Define original planes, and perspective plane.

5, 6. Likewise visual rays and point of sight.

7, 8. Also vanishing points and vanishing planes.

9, 10. Also horizontal line and centre of the picture.

11, 12. Define distance of the picture,—distance of a vanishing point.

13, 14. Also ground plane and ground line.

15. Define parallel perspective.

16. Also oblique perspective.

17. What is a bird's-eye view?

18. What is the effect upon the picture when any object is farthest from the eye?

19. When do all lines tend to a point in the picture?

20. What lines have the same vanishing point?

21. What is the vanishing point of all lines perpendicular to the picture?

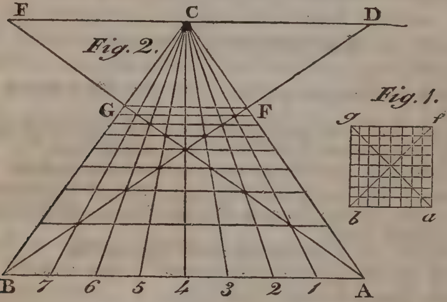
22. What lines have no vanishing point?

23. What figures do circles become in perspective?

24. On what principle is the perspective of circles, as well as of other curves founded?

4. *Practical Examples in Perspective.*

Example 1. *To draw a square pavement in perspective.*



1. Suppose your piece of pavement to consist of 64 pieces of marble, each a foot square; as in Fig. 1. * You first draw an ichnographical plan or ground plot of this, which is easily done, since it consists in nothing more than the subdivision of the line *a b* into 8 equal parts: from *b* raise the perpendicular *b g*, which make equal to *a b* and divide into 8 equal parts. Parallel lines drawn through these points divide the whole figure into 64 squares. Then rule the diagonals *a g*, *b f*, and your ground plot will appear as in figure 1.

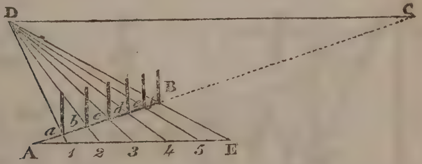
2. Now, to lay this in perspective, draw another square to your intended size, and divide the base line A B, (Fig. 2) into 8 equal parts, as before; then draw

* When an object is to be drawn in perspective, all its parts must be measured, so that we may be able to lay them down from a scale of equal parts.

the horizon D E, at any distance from B A; and from the division 4 in A B raise the perpendicular 4 C; C is now the point of sight; set off C D, C E, respectively equal to 4 A or 4 B; draw the diagonals B D, A E; and from C draw the cone of rays *(lines)* C B, C 7, C 6, C 5, C 3, C 2, C 1, C A. Then, from the point G where the diagonal A E intersects B C draw G F parallel to B A, or E D. The parallel G F in the perspective representation is the abridgment of *g f*, in the original square.

3. Then through the points where the diagonals cross the rest of the lines converging in C draw lines parallel to the base B A; and your square pavement will be represented in perspective as in Fig. 2. The intersections of these lines are all shown in the diagram.

Example 2. To divide a line in perspective, which is parallel to the horizon, and which tends to a vanishing point, into any number of equal parts; or to divide it in any required proportion.



1. Let A B be the line going to its vanishing point C; and suppose we are required to divide it into 6 equal parts.

2. Let C D be the horizontal line, and A E the ground line; parallel the one to the other.

3. Lay off at pleasure, C D for the distance of the

picture; if C be the centre of the picture, D is its distance.

4. Draw a line from D, touching the end B of the line to be divided; and produce D B to E, cutting the ground line in E.

5. Now A E represents the actual dimensions of the line A B which is seen in perspective.*

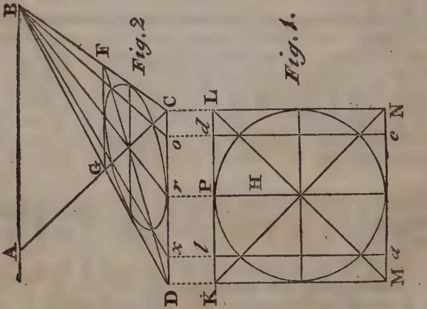
6. Divide A E into the same number of equal parts into which you proposed to divide the given line A B; as A 1, 2, 3, 4, 5.

7. Then from these different divisions draw lines to D, cutting the line A B in *a*, *b*, *c*, *d*, *e*, *f*, which will represent the number of equal parts, but diminishing in size as they are further removed from the eye.

Observation. Doors, windows, arches, colonnades, &c. are drawn in perspective on the same principle.

Example 3. *To draw a circle in perspective.*

Observation. The perspective representation of every circle is an ellipse (art. 23. p 246); and the perspective of circles is found by drawing round them reticulated squares (art. 24. p. 247)



* This gives a rule also for finding the real length of any line which tends to a vanishing point.

1. The circle H is circumscribed by the square K L N M, and the diagonals M L, N K are drawn; also through the points where these diagonals cut the circle, we draw *a l*, *c d*, parallel to M K and NL, respectively.

2. This circle with all these lines about it is now to be put in perspective, as follows:

3. Draw A B for the horizontal line, fix B for the centre of the picture, and A for its distance.

4. Make C D=K L; join D B, C B, and C A.

5. Make D *x*=K *l*; D *r*=K P; D *o*=K *d*; and join *x* B, *r* B, *o* B.

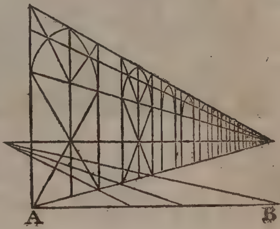
6. Through the intersection of D B and C A, at G, draw G F parallel to A B or D C; and now C D G F is the perspective representation of the square K L N M.

7. The horizontal and oblique lines present a reticulated or net-work figure within which we draw an ellipse to represent the original circle M, by tracing, in the reticulated square, with a steady hand, a curve through all those points which represent the real points in the original reticulated square.

Observation. Though it may appear difficult to ascertain the axes of this ellipse, it is nevertheless a regular ellipse, as your eye alone will easily discover by a little practice.

Example 4. To draw a colonnade, or rows of arches.

1. The width of the arches and piers is obtained in the same manner as was shown in Example 2d, by laying their dimensions upon the ground line A B, and drawing lines to the *distance point*



2. The curves of the arches are then found, by drawing the lines which correspond to those in the half square (of the circle, Ex. 3) in the same manner as the ellipse was described for the circle in Example 3rd.

Note. These arches are in oblique perspective.

Example 5. To put a landscape into scenic perspective under an oblique view.

1. Draw the horizontal line A B ; then, if your favorite object be on the right hand, as at C, place yourself on the left hand, upon the base line, as at D ; then from that station erect a perpendicular, D E, which will pass through the horizon at the point of sight F ; to which rule the diagonals G F and H F, which will show the roof and base of your principal building C : and will also serve for a standard for all the rest.

2. Observe also, either in direct or oblique views, whether the prospect before you make a curve ; for if it does you must be careful to make the same curve in your drawing.

Example 6. *To draw a perspective view in which are accidental points.*

1. Rule your horizontal line *a h*, and on one part of it fix your point of sight, as at *c*; from this rule the diagonals *c d*, *c e* on the one side, and *c f*, *c q* on the other. These lines now show the roofs and bases of all houses in the street directly facing you (supposing yourself placed at A, in the centre of the base line).

2. Then fix your accidental points *g* and *h*, upon the horizontal line, and rule from them to the angles *i k* and *l m*, (where the streets on each side take a different direction, towards the accidental points *g* and *h*) and the lines *h i*, and *h k*, give the roofs and bases of all the buildings on one side, as *l g*, and *m g* do on the other.

Observation. Accidental points seldom intervene, where the distance is small, as in noblemen's seats, groves, canals, &c. which may be drawn by the strict rules of perspective; but where the prospect is extensive and varied, including mountains, bridges, castles, rivers, precipices, woods, cities, &c., it will require such an infinite number of accidental points, that it will be better to do them as nature shall dictate, and your ripened judgment approve.

CHAPTER XIX.

Drawing and Painting.

1. *Of Drawing.*

1. Drawing forms an elegant and agreeable amusement for leisure hours, and has besides so wide a range of general utility, that it cannot fail to be attractive. Moreover it is the basis of *painting*, *designing*, *sculpture*, *architecture*, *engraving*, *modelling*, *carving*, and most of those arts, which are the offspring of fancy, and which embellish civilized life.

2. The *implements* and *materials* used in drawing, are drawing boards, parallel rulers, tee-squares, dividing compasses, black-lead pencils, Indian rubber, Indian Ink, hair pencils, charcoal, black chalk, stumps, white chalk, red chalk, drawing paper, middle tint paper.

3. From drawing the human figure, and expressing the passions, the pupil proceeds to draperies, then to landscapes, and the practice by hand of the rules of perspective.

4. Mechanical drawing is drawing by geometrical rules. In it genius or taste has nothing to do. It is an art altogether mechanical, which, like writing, may be acquired by every person possessed of moderate talents.

Observation. 1. By mechanical drawing we represent all sorts of apparatus, as steam-engines, coaches,

ploughs, and machinery of every kind. In finished mechanical drawings the shadows of such objects as are laid down must be given upon the principles of incidence and reflection of the rays of light; and all geometrical drawings should be shadowed by these rules, and not by guess. (*See Nicholson's Principles of Architecture, 3 vols. 8vo.*)

2. Connected with mechanical drawing is the method of copying a print, drawing or painting by means of tracing or transparent paper, and by means of the camera obscura in landscape drawing. But no youth will ever make progress in drawing, who does not trust solely to his own eye and hand; for whatever may be the mechanical methods recommended, they belong to the engraver's practice, not to the learner's.

2. *Of the Schools of Painting.*

5. A SCHOOL, in the fine arts, denotes a class of artists who have learned their art from a certain master, either by receiving his instructions, or studying his works; and who, of consequence, discover more or less of his manner, from the desire of imitation, or from the habit of adopting his principles.

Observation. All the painters which Europe has produced since the renovation of the arts, are classed in the following Schools:

6. *The School of Florence*, remarkable for greatness; for attitudes seemingly in motion; for a certain dark severity; for an expression of strength, by which grace perhaps is excluded; and for a character of design approaching to the gigantic.

Observation. 1. This school has an indisputable title to the veneration of all the lovers of the arts, as the first in Italy which cultivated them.

2. Painting, which had languished from the destruction of the Roman Empire, was revived by CIMABUE, born of a noble family in Florence in the year 1240. Andrew Castagna was the first Florentine who painted in oil. But Leonardo da Vinci and Michael Angelo, contemporary painters, were the glory of the Florentine School.

7. THE ROMAN SCHOOL was altogether devoted to the principal parts of the art, to those which require genius and vast conceptions; and was no farther occupied with colors than what was necessary to establish a difference between painting and sculpture, or rather between painting, varied with colors, and in claro-obscuro.

Observation. At the head of this school is placed Raphael Sanzio, born at Urbino in 1483.

8. THE VENETIAN SCHOOL is *the child of nature;* for the Venetian painters, not having under their eyes, like the Romans, the remains of antiquity, were destitute of the means of forming just ideas of the beauty of forms and of expression. Coloring was their chief object, and in this they succeeded.

Observation. Giorgione and Titian are considered the founders of the Venetian School.

9. THE LOMBARD SCHOOL boasts as its distinguishing characteristics *grace;* an agreeable *taste for design,* without great correction; *a mellowness of pencil;* and a beautiful *mixture of colors.*

Observation. Antonio Allegri, called Corregio, was the father and greatest ornament of this school. But the Carracci, (Lewis, Augustin, and Annibal,) formed what is called the *second* Lombard School, which is frequently distinguished by the name of the *Bologna School.*

10. THE FRENCH SCHOOL has varied so much under different masters, that it is difficult to characterize it. Some of its artists have been formed on the Florentine and Lombard manner; others, on the Roman; others, on the Venetian; and a few have distinguished themselves by a manner which may be called their own.

Observation. 1. In speaking in general terms of this school, it appears to have no peculiar character; and it can only be distinguished by its aptitude to imitate easily any impression; but it unites, in a moderate degree, the different parts of the art without excelling in any one of them.

2. Vouet laid the foundation of the French School; Le Brun finished the edifice. But Poussin, simple, careful, pure and correct in his manner, was the Raphael of France; and Le Sieur perhaps excelled all in drapery and in disposing the folds in the most artful and noble manner.

11. THE GERMAN SCHOOL. Though we have called it so, there is strictly speaking no German School; for, in Germany, painting has been prosecuted by a continuation of single, nay, solitary artists, who derived their manner from different sources of originality and imitation.

Observation. Albert Durer was the first German who corrected the bad taste of his countrymen. John Holbein, nearly contemporary with Durer, painted in both oil and water colors.

12. THE FLEMISH SCHOOL is recommended to the lovers of the art by the discovery, or at least the first practice of oil painting. This school is remarkable for great brilliancy of colors, and the magic of the claro-obscuro. To these may be joined a profound design, which is yet not founded on the most beautiful forms; a composition possessed of grandeur; a certain nobleness of air in the figures; strong and natural expressions; in short, a sort of beauty which is neither copied from the ancients, nor from the Roman or Lombard Schools; but which, as it deserves, is capable of pleasing.

Observation. John Van D'Eyck discovered the art of painting in oils; John of Bruges is reckoned the founder of painting, as a profession, in Flanders; but Peter Paul Rubens was the founder of the art. His chief merit consists in coloring, but even in this he is excelled by Titian; yet no painter ever invented and executed with the same facility. In historical, portrait, and landscape painting; in fruits, flowers and in animals, he excelled equally.

13. THE DUTCH SCHOOL. To speak in general terms, and without regarding a great number of exceptions, the Dutch School carries none of the above qualities to great perfection except that of coloring. Far from excelling in the beauty of heads and of forms, the Dutch painters seem to delight in the exact imitation of the lowest and most ignoble of our species. Their subjects are derived from the tavern, the smith's shop, and from the vulgar amusement of the rudest

peasant. The expression of the passions is sufficiently marked, but it is the expression of passions that debase instead of ennobling human nature.

Observation. Lucas of Leyden is the patriarch of the Dutch School; Cornelius Polembourg may be regarded as the father of its miniature painting; and the celebrated Rembrandt Vauryn is the prince of the grotesque figure of a Dutch peasant, or the servant of an inn, or the imitation of truth in the vulgar painting of low figures, with as much application as the greatest masters of Italy should have studied the Apollo of Belvidere, or the Venus de Medicis.

14. THE ENGLISH SCHOOL, founded in our own time, is connected with the Royal Academy instituted in London in the year 1766. The English painters have excelled in portraits and in drawing miniatures.

Observation. Dobson in the reign of Charles I. was the father of the English School of portrait painting. Lely was chiefly celebrated for painting females; and Kneller, in the reigns of James II. and William, was the fashionable artist. Thornhill is known for his fresco in the Dome of St. Paul's and the Painted Hall at Greenwich; and his son-in-law Hogarth stands unrivalled as a painter of natural humor. Richardson was a portrait painter of eminence; Hudson was his best pupil; but Reynolds, under Royal auspices, was the founder of the English School of Painting. Fuseli's boundless imagination has attempted with surprising effect, to embody every thing in the free rich and uncontrolled regions of fancy. West, Barry, Gainsborough, the Smiths of Chichester, Wilson, Northcote, Opie, Lawrence, Wilkie, &c. with their respective excellences and merits, are well known to the public.

Questions for Examination.

1. Of what is drawing the basis?
2. What are the implements and materials used in drawing?
3. How does the pupil proceed in drawing?
4. What is mechanical drawing?
5. Define a *School* in the fine arts.
6. Describe the School of Florence.
7. Describe the Roman School.
8. Also the Venetian School.
9. Likewise the Lombard School.
10. What is recorded of the French School?
11. Describe the German School.
12. Give me the particulars of the Flemish School.
13. Also those of the Dutch School.
14. In like manner those of the English School.

3. *Principles of the Art.*

1. PAINTING may be defined a mode of communicating ideas to the mind, by means of a representatation of the visible parts of nature.

2. The chief ingredients or principles are *invention, composition, design, expression of the passions,* and *coloring.*

3. INVENTION, in painting, consists principally in three things: first, the choice of a subject properly within the scope of the art; secondly, the seizure of the most striking and energetic moment of time for representation; and, lastly, the discovery and selection of such objects, and such probable incidental circumstances, as, combined together, may best tend to develope the story, or augment the interest of the piece.

4. COMPOSITION. The judicious disposal of the materials furnished by the imagination, or invention, in such a manner as best to contribute to the beauty, the expression, and the effect of the picture, constitutes what is termed *composition* in painting.

5. DESIGN. In the process of painting, *design* may properly be said to follow next after *composition;* for although this part of the art is in a certain degree requisite, even in making the first rude sketch, it is not until afterwards that the artist exerts his utmost powers to give that exact proportion, that beauty of contour, and that grace and dignity of action and of deportment to his figures, which constitute the perfection of painting.

That which was at first only hinted at, is now to be defined. A few rude and careless lines were sufficient in the sketch to indicate the general attitude and expression of the figure; now the utmost precision is required not only in the outline of the naked parts, but even in the delineation of the most complicated windings of a lock of hair, or the intricate folds of a drapery. Hence a very high degree of excellence in design, is perhaps justly considered the greatest difficulty of painting.

6. EXPRESSION OF THE PASSIONS. That language, which above all others a painter should carefully endeavour to learn, and from nature herself, is the language of the passions.

Without it the finest production of the pencil and the brush must appear lifeless and inanimate; the propriety of dress, the beauty of colors, the magic of

light and shade, must be all set off by the life and the speech of grief, joy, fear, anger, love, hope, desire; as one or other of these passions clothes the countenance of the figure who is its subject.

7. CLAIR OBSCURE, or CHIARO-SCURO, is the art of distributing the lights and darks in a picture, in such a manner as to give at once proper relief to the figures, the best effect to the whole composition, and the greatest delight to the eye.

8. COLORING is the art of giving to every object in a picture its true and proper hue as it appears under all the various circumstances and combinations of light, middle tint, and shadow; and of so blending and contrasting the colors, as to make each appear with the greatest advantage and beauty, at the same time that it contributes to the richness, the brilliancy, and the harmony of the whole.

Questions for Examination.

1. Define painting.
2. What are the chief ingredients of the art?
3. Define *Invention.*
4. Also *Composition.*
5. Likewise *Design.*
6. Now *Expression of the Passions.*
7. What is *Clair Obscure?*
8. What is the excellence of *Coloring?*

4. *Of the Different Classes of Painting.*

Observation. As all the objects in nature are susceptible of imitation by the pencil, the masters of this art have applied themselves to different subjects, each one

as his talents, his taste, or his inclination may have led him; and from this diversity of pursuit have arisen the following different classes of painting:

1. HISTORY PAINTING, which, as it represents the principal events in history, sacred and profane, civil and military, real or fabulous, and also every species of allegorical expression, produces the most sublime creations of the art.

Observation. In Historic painting Raphael, Guido, Rubens, Le Brun, West, &c. have excelled.

2. RURAL HISTORY, or the representation of a country life, of villages and hamlets, and their inhabitants, though of an inferior class to historic painting, has been rendered at once pleasing and graceful by the productions of Teniers Gainsborough, and Westal.

3. PORTRAIT PAINTING has engaged the attention of the greatest masters in all ages, as Apelles, Guido, Vandyke, Rembrandt, Kneller, La Tour, Reynolds, West, Lawrence, &c.

4. GROTESQUE HISTORIES are the nocturnal meetings of witches; sorceries and incantations; the operations of mountebanks, &c. a sort of painting in which the younger Breughel, Teniers, Hogarth, &c. have exercised their talents with success.

5. BATTLE PIECES have rendered many artists famous.

6. LANDSCAPES, a charming species of painting, cultivated successfully by the greatest masters of all ages and countries.

7. SEA PIECES, ***harbors, gales, storms***, present scope for displaying all the principles of the art in the sublime of nature, the convulsions of the elements, &c.

8. In NIGHT PIECES, either as the objects have been illuminated by the moon's beams, or torches, or conflagrations, or bombardments, many artists have excelled.

9. LIVING ANIMALS, a more difficult branch of the art than many people imagine, have been marvellously well painted by Rosa, Carré, Vandervelde, Westal, and Daniels.

10. BIRDS *of all kinds* require great patience minutely to express the infinite variety and delicacy of their plumage.

11. CULINARY PIECES, representing all sorts of provisions, and animals of the poultry yard or the chase, fishes, &c., require only a servile imitation of objects, which, from the very circumstance of their being lifeless, are but little pleasing to the generality of spectators.

12. FRUIT PIECES of every kind imitated from nature, are delightful to look on.

13. FLOWER PIECES, a charming class of painting, inspire the student to rival nature. *Plants* and *insects* are usually referred to the painters of flowers, who with them ornament their works.

14. In PIECES OF ARCHITECTURE the Italians excel all others.

15. Instruments of Music, *pieces of furniture, &c.* are a trifling class, in which artists only accidentally employ their talents.

16. Imitations *of Bas-Reliefs* are a very pleasing species of painting, and by an able hand may be carried to great excellence.

17. Hunting Pieces require a peculiar talent, as they unite the painting of men, horses, dogs, game, landscape, &c.

18. Enamel Painting differs from all other kinds of painting, in the vehicle employed for the colors to hold the parts together, and bind them to the ground they are laid upon.

This vehicle is glass, or some vitreous body, which being mixed with the colors, and fused, or melted, by means of heat, becomes fluid; and, having incorporated with the colors in that state, forms together with them a hard mass when grown cold; it answers, therefore, the same end in this, as oil, gum-water, size, or varnish, in the other kinds of painting.

Questions for Examination.

1. Define *History* painting; name its masters.
2. Also *Rural* History; and its masters.
3. Now *Portrait* painting; and its masters.
4. Define *Grotesque* histories; name their painters.
5, 6. Also *Battle* pieces and *Landscapes.*
7, 8. *Sea* pieces, and *night* pieces also.
9, 10, 11. *Living Animals, Birds,* and *Culinary* pieces.
12, 13, 14. *Fruit, flowers,* and *Architecture.*
15, 16. *Instruments of music, furniture,* and *Imitations of bas-relief.*
17, 18. *Hunting* pieces and *Enamel Painting.*

CHAPTER XX.

Sculpture and Engraving.

1. *Of Sculpture.*

1. *Definition.* Sculpture is the art of carving wood, or of hewing stone into images.

Observation. This art is of very remote origin, and probably sprung from the deification of heroes. And there is little reason to assign its origin to idolatry, although probably image-worship contributed to bring it to perfection.

2. *Egyptian Sculpture.* Among the Egyptians we find the best specimens of sculpture in the most remote antiquity; but the persons of the Egyptians, destitute of the graces of form, devoid of elegance or of symmetry, presented no standard for the sculptor's chisel.

The Egyptians resembled the Chinese in the cast of their faces, in their great bellies, and in the clumsy rounding of their contours. They were restrained by severe laws to the principles and practices of their ancestors, and were not permitted to introduce any innovations. Hence the art of sculpture was ever in its infancy in Egypt, as Astronomy is now in China. And to recommend it to the pupil, would be only approving deformity for beauty.

3. *Of the Phenician Sculpture.* The Phenicians possessed both a character and a situation

highly favorable to the cultivation of Sculpture; but though their temples shone with statues chiselled from the beautiful models of their own graceful persons, all their great works have been destroyed, and we now only judge of their excellence in this art from ten medals in the cabinet of the king of Etruria.

4. *The ancient Etrurian Sculpture*, strongly marked in character, was of a style harsh and overcharged. The people were rude, their productions were so also.

Observation. Two styles prevailed in the Etrurian art; in the one, the lines are straight, the attitude stiff, and no idea of beauty appears in the formation of the head; and in the second, the joints are strongly marked, the muscles raised, the bones distinguishable; but the whole mien harsh. This last describes also the style of Michael Angelo, and of his numerous imitators.

5. The GRECIAN SCULPTURE excelled all of that art in antiquity. The age of Pericles, the era of luxury and splendor, was the golden age of the arts in Greece. The acquisition of fame was then the capital inducement to exertions of genius; but as a secondary excitement we must assign a large portion to the *Theology* of the Greeks, which furnished ample exercises for the genius of the architect and the sculptor.

Obs. But that which enabled the Grecian artist to excel in sculpture was the advantage he enjoyed of studying the human figure naked, in all its various attitudes, in the Palæstra, and in the public games. The antique statues have, thence, a superior grandeur united with perfect simplicity, because the attitude is

not the result of an artificial disposition of the figure. as in the modern academies, but is an exhibition of unconstrained nature.

Example. Thus. in the *Dying Gladiator*, we observe both the relaxation of the muscles, and the visible failure of strength and life; we cannot thence doubt, that nature was the sculptor's immediate model of imitation.

6. The Grecian ideas of beauty in the different parts of the human body are these:

1. With respect to the head, the *profile*, which they chiefly admired, is peculiar to dignified beauty. It consists in a line almost straight, or marked by such slight and gentle inflexions as are scarcely distinguishable from a straight line: in the figures of women and young persons, the forehead and nose form a line approaching to a perpendicular.

2. The *forehead* they reckoned, when small, to be a mark of beauty; and large of deformity.

3. Large *eyes* are in general agreed to be beautiful, but their size is of less importance than their form, and the manner in which they are enchased. Hence by deepening the cavity of the eye, the statuary increases the light and shade, and thus gives the head more life and expression.

4. The beauty of the *mouth* is peculiarly necessary to constitute a fine face: the lips of Venus are *half* open.

5. The rounding of the *chin*, in figures of ideal beauty, the Grecian artists never interrupted by a dimple, but to distinguish individuals they did so.

6. The *ears* were executed by the Greeks with no less attention than the other members of the body.

7. The *hair* in ancient Grecian statues will be found long and curling, except in likenesses, in which they copied the person's hair exactly. *Fair hair* was in most estimation among the Greeks, who invariably give this color to all their goddesses and heroes

8. In the execution of the *hands* and *feet*, peculiar attention to the neatness of the formation was observed;

and to the feet they gave the most beautiful turning, while the hands of young persons were plump, with little cavities or dimples at the joints of the fingers.

9. In the *knees* of young persons they marked the joint but faintly, and the knee united the leg to the thigh, without making any remarkable projections or cavities.

10. The *breasts* of men were large and elevated: the breasts of women did not possess much amplitude. And the breasts of the nymphs and goddesses were never represented swelling, because that is peculiar to those who suckle.

7. *Of the drapery of Grecian statues.* The Grecian sculptors were scrupulous in giving to their statues such drapery as was best calculated to give effect to their design; and the feet they covered with shoes or sandals.

8. *Proportion of the figure.* The body consists of three parts, as well as the members.

The three parts of the body are, the trunk, the thighs, and the legs. The inferior parts of the body are, the thighs, the legs, and the feet. The arms also consist of three parts, and these must bear a certain proportion to the whole, as well as to one another. In a well formed man the head and body must be proportioned to the thighs, the legs, and the feet, in the same manner as the thighs are proportioned to the legs and the feet, or the arms to the hands. The face also consists of three parts, *viz.* three times the length of the nose.

9. The materials of Grecian statues were at first clay, then wood, marble, ivory, silver and gold. The three last were used only in small statues, and the wood in that which they wished not to preserve.

Questions for Examination.

1. Define Sculpture, and shew its antiquity.
2. How was it cultivated by the Egyptians?
3. How also by the Phenicians?
4. How likewise by the Etrurians?
5. How did the Greeks' excellence arise in this art?
6. What are the Grecian ideas of the beauty of the *profile*, the *forehead*, the *eyes*, the *mouth*, the *chin*, the *ears*, the *hair*, the *hands* and *feet*, the *knees*, the *breasts*, &c.?
7. What is said of the drapery?
8. What are the different proportions of the figure and its several parts?
9. Of what materials did the Grecian artists make their statues?

2. OF ETCHING AND ENGRAVING COPPER PLATES.

1. ETCHING is a manner of engraving on copper, in which the lines or strokes, instead of being cut with a tool or graver, are corroded in with aquafortis.

Observation. Etching is a much later invention than the art of engraving by cutting lines on the copper; but in almost all the engravings on copper that are executed in the stroke manner, both etching and engraving are combined.

2. ENGRAVING, or *graving*, as it is generally called, is cutting lines upon a copper-plate, by means of a steel instrument called a graver, without the use of aquafortis.

Observation. This was the first way of producing

copper-plate prints, and is still much practised in historical subjects, portraits, and in finishing landscapes.

3. MEZZOTINTO SCRAPING is of a late date, and recommends itself by the amazing ease with which it may be executed by those who understand drawing.

Observation. Mezzotinto prints are those which have no hatching, or strokes of the graver, but whole lights and shades are blended together, and appear like a drawing in Indian-Ink. They are different from *aquatinta*; but as both resemble Indian-Ink the difference is not easily described. *Mezzotinto* is applied to *portraits*, and *historical* subjects; and *aquatinta* is used only for *landscape* and *architecture*.

4. AQUATINTA is a method of producing prints very much resembling drawings in Indian Ink.

5. ENGRAVING ON WOOD is a process exactly the reverse of engraving on copper. In the latter, the strokes to be printed are sunk or cut into the copper, and a rolling-press is used for printing it; but in engravings on wood, all the wood is cut away, except the lines to be printed, which are left standing up like types, and the mode of printing is the same as that used in letter-press; that is to say, in the printing of this book.

Observation. The diagrams in the several pages of this volume are from wood-engravings cut out of box-wood.

6. ETCHING ON GLASS is performed by means of fluoric acid, in different ways, so that

beautiful ornaments may be etched on glass, and applied to decorate windows.

Note. The student will find this process developed scientifically in "the ELEMENTS OF NATURAL AND EXPERIMENTAL PHILOSOPHY," which is to be considered as a sequel to this volume, for the use of schools and private teachers.

7. ENGRAVING ON STONE, a very late invention, is rather the art of printing from, or multiplying designs made upon the surface of the stone. The art is called *lithography.*

Questions for Examination.

1. What is *etching* ?
2. Describe *engraving.*
3. Also *Mezzotinto* scraping.
4. Define *aquatinta.*
5. What is engraving on wood ?
6. What is etching on glass ?
7. What is engraving on stone ?

CHAPTER XXI.

Music.

1. *Definition.* Music is the art of combining sounds in a manner agreeable to the ear. And the principles upon which various combinations of sound are founded, constitute the science of music.

2. *Speculative* music is the knowledge of the nature and use of those materials which compose it, or, in other words, of all the different relations between the high and low, between the harsh and the sweet, between the rapid and the slow, between the strong and the weak, of which sounds are susceptible.

3. *Practical* music is the art of applying and reducing to practice those principles which result from the theory of agreeable sounds, whether simultaneous or successive; or, in other words, to conduct and arrange sounds according to the proportions resulting from consonance, from duration and succession, in such a manner as to produce upon the ear the effect which the composer intends. This is the art which we call *composition.*

Observation. 1. *Speculative* music is divided into *measure* and *time*, or *harmonical* and *rhythmical* music.

2. *Practical* music is divided into *melody* and *harmony*.

3. By *melody* the successions of sound are regulated in such a manner as to produce pleasing airs.

4. *Harmony* consists in uniting to each of the sounds, in a regular succession, two or more different sounds, which simultaneously striking on the ear, soothe it by their concurrence.

5. A *chord* is a combination of several sounds heard together: hence harmony is a series of chords; and a single chord is sometimes called harmony.

6. An *interval*, in melody or harmony, is the distance or difference in pitch between one sound, and another higher or lower than the first sound.

4. That we may learn to distinguish the intervals, and the manner of perceiving them, let us take the ordinary scale C, D, E, F, G, A, B, C, which every person, whose ear or voice is not extremely false, naturally modulates.

Illustration. The sound D is higher or sharper than the sound C, the sound E is higher than the sound D, the sound F higher than the sound E, &c., and so on through the whole *octave;* so that the interval or distance from the sound C to the sound D, is less than the interval or distance between the sound C and the sound E, the interval from C to E is less than that between C and F, &c., and in short that the interval from the first to the second C is the greatest of all.

5. On these intervals are founded *tones, semitones*, or second *majors*, second *minors*, third *majors*, third *minors*, &c. to the full *octave*.

6. A sound in the musical scale is called *sharp*, when it is raised a semitone; and it is marked with this character ♯: thus, ♯ C signifies C *sharp*, that is to say, C raised a semitone above its pitch in the natural scale. A sound in the scale depressed a semitone is called *flat*, and is

marked thus ♭: thus ♭ A signifies A *flat*, or A depressed a semitone.

Observation. Though we might prove the musical scale mathematically, in an Elementary work, we decline it for these reasons: the solid contents of sonorous bodies, and their degrees of cohesion or elasticity cannot be ascertained with such precision as to render the conclusions deduced from them geometrically true. But sound is a secondary quality of matter, and secondary qualities have no obvious connexion which we can trace with the sensations produced by them. Experience, therefore, and not speculation, is the grand criterion of all musical phenomena.

7. The agreeableness of vocal music differs from that of instrumental; the former, being intended to accompany words, ought to be expressive of the sentiment which they convey; but the latter, having no connexion with words, may be agreeable without any relation to sentiment. Harmony, properly so called, though delightful when in perfection, hath no relation to sentiment; and we often find melody without the least tincture of it.

8. In vocal music, the intimate connexion of sense and sound rejects dissimilar emotions, those especially that are opposite. Similar emotions, produced by the sense and the sound, go generally into union; and at the same time are concordant or harmonious; but dissimilar emotions, forced into union by these causes intimately connected, obscure each other, and are also unpleasant by discordance.

9. These illustrations make it easy to determine what sort of poetical compositions are fitted for music.

Illustration 1. As music in all its tones ought to be agreeable, it can never be concordant with any compositions in language expressing a disagreeable passion, or describing a disagreeable object, for here the emotions raised by the sense and by the sound, are not only dissimilar but opposite; and such emotions, forced into union, produce always an unpleasant mixture.

Example 1. MUSIC accordingly, says LORD KAIMES, is a very improper companion for sentiments of malice, cruelty, envy, peevishness, or any other dissocial passion; witness, among a thousand, King John's speech in Shakspeare, soliciting Hubert to murder Prince Arthur, which, even in the cursory view, will appear incompatible with any sort of music.

2. MUSIC is a companion no less improper for the description of any disagreeable object, such as that of Polyphemus, in the 3d Book of the Æneid; or that of Sin, in the 2d Book of Paradise Lost—the horror of the object described, and the pleasure of the music, would be highly discordant.

Illustration 2. With regard to *vocal music*, there is an additional reason against associating it with disagreeable passions. The external signs of such passions are painful; the looks and gestures to the eye, and the tone of pronunciation to the ear: such tones, therefore, can never be expressed musically, for music must be pleasant, or it is not music.

3. On the other hand, *Music* associates finely with poems that tend to inspire pleasant emotions: music, for example, in a cheerful tone, is perfectly concordant with every emotion in the same tone; hence our taste for airs expressive of mirth and jollity.

4. Sympathetic joy associates finely with cheerful music; and sympathetic pain no less finely with music that is tender and melancholy. All the different emo-

tions of love, namely, *tenderness, concern, anxiety, pain of absence, hope, fear,* accord delightfully with music: and consequently, a person in love, even when unkindly treated, is soothed by music; for the tenderness of love still prevailing, accords with a melancholy strain.

Example 3. This is finely exemplified by SHAKSPEARE in the 4th Act of *Othello*, where Desdemona calls for a song expressive of her distress. Wonderful, indeed, is the delicacy of that Poet's taste, which never fails him, not even in the most refined emotions of human nature!

Observation. Melancholy music is suited to slight grief, which requires or admits consolation; but deep grief, which refuses all consolation, rejects, for that reason, even melancholy music.

Illustration 5. Where the same person is both the actor and the singer, as in an Opera, there is a separate reason why MUSIC should not be associated with the sentiments of any disagreeable passion, nor with the description of any disagreeable object: this separate reason is, that such an association is altogether unnatural.

Example 4. The pain which a man feels who is agitated with malice or unjust revenge, disqualifies him for relishing music, or any thing that is pleasing; and, therefore, to represent such a man, contrary to nature, expressing his sentiments in a song cannot be agreeable to any audience of taste.

Illustration 6. For a different reason music is improper for accompanying pleasant emotions of the more important kind, because these totally engross the mind, and leave no place for music, nor for any sort of amusement.

Example. In a perilous enterprise to dethrone a tyrant, music would be impertinent, even where hope prevails, and the prospect of success is great. Thus Alexander attacking an Indian town, and mounting the wall, had certainly no impulse to exert his powers in a song.

ON HEARING MUSIC.

YON organ! hark! how soft, how sweet,
The warbling notes in concert meet!
The sound my fancy leads
To climes where Phœbus' brightest beams
Gild jasmine groves, and crystal streams,
And lily-mantled meads.

Now, different tones and measures flow,
And gravely deep and sadly slow,
Involve the mind in gloom;
I seem to join the mournful train,
Attendant round the couch of Pain,
Or leaning o'er the tomb.

Now loud the tuneful thunders roll,
And rouse and elevate the soul
O'er earth and all its care;
I seem to hear from heavenly plains
Angelic choirs' responsive strains,
And in their raptures share.

SCOTT.

Questions for Examination.

1. Define music.

2, 3. Define speculative and practical music. And show into what each is divided, and what melody, harmony, a chord, and an interval are.

4. Define and illustrate the scale.

5. What are tones, semitones, &c.?

6. Define now sharps and flats.

7, 8. How does the agreeableness of vocal music differ from that of instrumental?

9. What sorts of poetical compositions are fitted for music?

CHAPTER XXII.

HISTORY.

1. *Definition.* HISTORY, in general, signifies an account of some remarkable facts which have happened in the world, arranged in the true order in which they actually took place, together with the causes to which they were owing, and the different effects they have produced, as far as they can be discovered.

2. HISTORY may be divided into three parts, *sacred*, *civil*, and *natural*.

3. SACRED HISTORY comprehends the narrative parts of the Old and New Testaments, and the history of the Church, commonly called ecclesiastical history. This embraces, in its capacious womb, the history of the Jews, both political and ecclesiastical; the history of the propagation, and the progress of Christianity, as far as they were carried on by Jesus Christ and his immediate successors the Apostles; and the history of the Christian church, from the æra of the apostles to the present time.

4. CIVIL, or, as some writers call it, *profane history*, in opposition to sacred, contains an account of the governments, of the civil and military transactions of nations; and displays those great exhibitions of human nature, which the preservation of the happiness of large communities of men,

and the convulsions of societies, frequently produce.

Illustration. Civil history is divided into the following branches by the late Mr. Barron.

1. The Creation of man. 2. The flood. 3. The beginning of profane History, i. e. when all the fabulous relations of heroes, demi-gods, &c. were expelled from historical narrations, and men began to relate facts with some regard to truth and credibility. 4. The conquest of Babylon by Cyrus, and the destruction of the Babylonian Empire. 5. The reign of Alexander the great, and the overthrow of the Persian Empire. 6. The destruction of Carthage by the Romans, when the latter had no longer any rival capable of opposing their designs. 7. The reign of the emperor Trajan when the Roman empire was brought to its utmost extent. 8. The division of the empire under Constantine. 9. The destruction of the Western Empire by the Heruli, and the settlement of the different European nations. 10. The rise of Mahomet, and the conquests of the Saracens and Turks. 11. The Crusades, and all the space intervening between that time and the present.

5. Another branch of civil, is *literary history;* or details of the origin and progress of learning, with the revolutions it has undergone in different ages and situations. Though the incidents of this branch are not so splendid as those of the former, they are entitled to regard.

Illustration. According to the author mentioned above, Civil history displays the qualities of the statesman and the warrior. Literary history unfolds the productions of the imagination, of the heart, and of the understanding, and illustrates the effects of external circumstances, in calling forth, or repressing the exertions of the man of genius, and of the philosopher. Next to provision for the safety and happiness of individuals and communities, the most meritorious objects of general attention, are those pursuits which advance the cha-

racter of human nature, and promote its civilization, its refinement, and its dignity.

6. Profane history includes farther, MEMOIRS, ANNALS, BIOGRAPHY, and is intimately connected with *antiquities*, *chronology*, and *geography*.

7. A MEMOIR is a familiar narration, in which the author attempts not the profound discussion, nor the dignity of style employed by the historian. The writer of memoirs presents a simple and plain relation of facts, and leaves reflections and comments to the reader.

Observation. A work of this sort, executed with ability, possesses many attractions, sufficient to gain admirers. It is generally more circumstantial, and more picturesque than regular history, and by admitting the reader into more intimate familiarity with the author, communicates instruction with the ease of conversation, without assuming the austere, and less pleasant tone of teaching.

8. ANNALS are a history constructed in the form of a journal, and bind it sometimes so closely in the trammels of chronology, that the author cannot depart from the order of time, nor anticipate any part of his narrative, to connect the several incidents of an event. The transactions that occur within the year must appear in their proper places; and if the events extend over several years before their completion, their annual portions are detached and related apart.

Observation. The annalist seldom attempts to throw much interest into his work, or to convey any knowledge besides a distinct and accurate view of facts. He

seldom endeavours to adorn his relation, or to interweave in it moral or political information. He undertakes the humble task of delineating with accuracy the naked facts, and leaves the historian to embellish them. He is properly the pioneer of the historian, and contributes greatly to shorten his labor, and to accelerate his progress.

9. Biography records the lives of eminent individuals, and is susceptible of much interest, as the personages may be selected from any order of society—They may be *men of letters*, of *pleasure*, of *business*—They may be *kings*, *statesmen*, *politicians*, *artists*, *warriors*.

Observation. The relation of their lives may comprehend entertaining strictures on the character and conduct of those with whom they have been connected, and important discoveries in the history of the times in which they have lived.

OF them, who wrapt in Earth are cold,
  No more the smiling day shall view,
Should many a tender tale be told,
  For many a tender thought is due.

Why else the o'ergrown paths of time,
  Would thus the letter'd sage explore,
With pain these crumbling ruins climb,
  And on the doubtful sculpture pore?

Why seeks he with unwearied toil,
  Thro' Death's dim walks to urge his way,
Reclaim his long asserted spoil,
  And lead Oblivion into day!

'Tis Nature prompts, by toil or fear
  Unmov'd, to range thro' Death's domain;

The tender parent loves to hear
Her children's story told again.
LANGHORNE.

10. ANTIQUITIES, CHRONOLOGY, and GEOGRAPHY, are the handmaids of history.

11. ANTIQUITIES contain discussions concerning *monuments*, *political*, *military*, *sepulchral*, or *etymological*, that transcend the limits of history, and relate to events, customs, or opinions, about which no other documents exist. The early transactions of all nations are involved in obscurity because the composition and preservation of records hardly appear, but in an advanced state of civilization.

Observation. There is, however, in mankind, a desire to perpetuate the memory of important events, as well as to investigate the manners, practices, and opinions, the meaning and origin of which are obscured by distance of time. Hence *stones*, and *coins*, and *columns*, the most durable materials with which men were acquainted before the use of writing, are naturally selected to gratify this desire.

Note. Chronology and Geography are treated elsewhere in this volume.

12. The third branch of history is termed NATURAL, and includes a large field of knowledge, both useful and entertaining; especially as it comprehends an account of all the phenomena in the heavens, and the productions on the earth, which are, or may be the objects of our senses, together with the changes that may be made

on these phenomena and productions by physical causes, or the means of art. This part of natural history, which Lord Bacon calls Narrative, addresses itself to the memory. The use which may be made of it, by induction, towards ascertaining the laws of nature, belongs to natural philosophy and chemistry.

Observation. Natural History, then, in this view, is divided into two branches, one containing the *productions of nature*, whether ordinary and regular, or extraordinary and monstrous; and the other, the *productions of art.* The natural historian recounts every fact and circumstance relative to these productions.

13. The Natural Historian divides the productions of the earth into *animals, vegetables*, and *minerals*.

Illustration. 1. Under animals he comprehends all living creatures, from man to the meanest insect; and of every species he attempts to deliver the history, as far as observation or information can afford him materials.

2. From animals, the natural historian proceeds to *vegetables.* He examines, and classifies, all the plants which the earth produces.

3. From the surface, he descends into the bowels of the earth, examines the nature and position of the *strata* of which it is composed, and all the varieties of *minerals* which it presents to his observation. But natural historians have too often spent their time in idle disputes about classification, rather than in adding to the general stock of knowledge, and enlarging our acquaintance with the objects that exist.

Observation. The history of nature is, for these reasons far from being complete; and the whole theory of general principles, which Lord Bacon calls the induction

part, and which he declares was totally wanting in his time, may still be affirmed to have advanced but a small space.

14. The *history of the* MECHANIC ARTS, or of those experiments and operations which are performed on the materials furnished by nature, forms the last branch of historic knowledge of which we shall treat.

Observation. It is vain in this volume to attempt a specification of the operations of the mechanic or useful arts. The materials, about which they are exerted, are almost as numerous and various as are the different substances and combinations of substances which this earth presents. Should you desire more accurate information you will have recourse to the works that treat exclusively on those arts, or to the practitioners who can give you, in one half hour, a better insight into any particular art, than you could gain from books in the half of a year.

Questions for Examination.

1, 2. Define History, and state its chief division.

3. What does *sacred* history embrace?

4. What does *civil* history represent, and into what branches may it be divided?

5, 6. What is said of *literary* history, and of a further division of profane history into memoirs, &c.?

7. What is a *Memoir*, and how is it executed?

8. What are *Annals*, and what is the business of the annalist?

9, 10. Define *Biography*, and name the three handmaids of history.

11. What are *antiquities*, and how studied?

12. What is *natural* history, and how is it divided?

13. How does the natural historian proceed?

14. What is the history of the *Mechanic* arts?

CHAPTER XXIII.

CHRONOLOGY.

1. *Definition.* CHRONOLOGY is a science which treats of time, showing different measures or computations that have been observed by different nations.

Observation. It enables us to date the beginning and end of the reigns of princes, the births and deaths of eminent persons, the revolutions of empires and kingdoms, battles, sieges, or any other remarkable events. And without distinguishing the times of events as clearly as their nature will admit, history would be a *heap* of confusion, destitute of light, order or beauty.

2. *Time* is divided into years, months, weeks, days, hours, minutes, and seconds; besides periods, centuries and cycles.

3. A year is the most complete period of time, being that space of time, wherein the earth finishes its course round the sun, returning to the same point from which it departed.

Illustration. 1. This consists of 365 days, five hours, and forty-nine minutes, and is called the *tropical* or *natural* year.

2. But that space of time, in which the sun, having departed from any fixed star, returns to the same again, is called the *sidereal* year, and contains 365 days, six hours, and ten minutes.

3. A *lunar* year is that space of time, in which the moon performs twelve complete revolutions round the

earth, called *lunations.* This year contains 354 days, eight hours, forty-eight minutes, and thirty-eight seconds.

Observation. Both the *tropical* and *lunar* years above described, are termed astronomical.

Illustration. 4. A *civil* year is the legal year, or that which each nation or government has appointed for common use. It consists of a certain number of whole days, without any odd hours or minutes, to render the computation of time more easy, and it is distinguished into *common* and *bissextile:* the common year consists of 365 days, and the *bissextile* or *leap year* (which is every fourth) of 366.

Observation. The addition of a day to every fourth year, is to make the *civil* year keep pace with the natural one: for the six hours, or thereabouts, by which the latter exceeds the former, in four years make a whole day; and therefore in every leap year, the month of February has twenty-nine days but in the common year only twenty-eight.

4. The reformation of the calendar is called the *Gregarian* account, or *New Style;* and according to this style was the calendar rectified in England, in 1752, by throwing out eleven days in the month of September, as from the council of Nice to that year 1427 years had elapsed, and besides the beginning of the civil year was fixed in 1752 to the first day of January. It had formerly been the 25th of March.

5. Forms of civil years. There have been, and still are, various forms of *civil* years, and as the form of the year is various among different nations, so likewise is its beginning.

The Jews, as most other nations, of the East, had a *civil* year, which commenced with the new moon in *September;* and an *ecclesiastical* year, which commenced from

the new moon in *March*. The Persians begin their year in the month answering to our June. The Chinese and most of the Indians begin it with the first moon in March, and the Greeks with the new moon that happens next after the summer solstice.

6. Of MONTHS. The principal division of the year is into twelve parts called months, these are either *astronomical* or *civil.*

Illustration. 1. An *astronomical* or *natural* month is that which is measured exactly by the motion of the earth or moon, and is accordingly either *lunar* or *solar.*

2. A *lunar* month is the time the moon takes to revolve round the earth, which she performs in twenty-seven days, seven hours, forty-three minutes, and eight seconds.

3. A *solar* month is that space of time in which the earth runs through one of the signs of the *zodiac.* And as the earth constantly travels through all the twelve signs in 365 days, five hours, and forty-nine minutes, the quantity of a mean solar month is found by dividing that number by twelve. And hence it appears that each of these months, one with another, contains thirty days, ten hours, twenty-nine minutes and five seconds.

4. *Civil* months are those which are framed to serve the uses of life, being made to consist of a certain number of whole days.

7. A month is divided into four parts called WEEKS, each consisting of seven parts called *days.* Of these months there are thirteen in a Julian year, and one day over; of weeks there are fifty-two; and of days 365, as before observed. The days of the week are known to every body.

Observation. (1.) The present Greeks begin their day at sun-rising, as did the ancient Babylonians, Persians Syrians, and most other eastern nations. The modern

Italians and Chinese reckon it from sun-setting; as did the ancient Jews, Athenians, Bohemians, and Silesians. The Arabians and modern astronomers begin the day at noon. The English, French, Dutch, Germans, Spaniards, Portuguese, and Egyptians, begin it at midnight.

(2.) The *Romans* divided their months, into *calends*, *nones*, and *ides;* calling the first day of every month its *calend*.

8. An *hour* has deen defined the twenty-fourth part of a natural day.

Observation. (1.) Different people reckon the hours in a different manner. Babylonish hours are those which are counted from sun-rising in a continued series of twenty-four. European hours are those counted from midnight, twelve from thence to noon, and from noon to midnight twelve more. Those which commence their order from noon, are called astronomical, because used by astronomers.

(2.) The Jews, Chaldeans, Arabs, and other eastern people, divide the hours into a *thousand* and *eighty* scruples, eighteen of which are equal to our minute.

9. Of Cycles. A *cycle* is a circle of years, months, and days, used by chronologers, to signify a perpetual round or circulation of the same parts of time, proceeding orderly from first to last, and recurring again from last to first, successively, and without interruption.

Illustration. As the annual motion of the sun, and other heavenly bodies, cannot be measured exactly without any remainder of minutes, seconds, &c., to swallow up these fractions in whole numbers, that is, such as only express days and years, *cycles* have been invented; which comprehending several revolutions of the same body, replace it after a certain number of years, in the same point of the heavens whence it first

departed, or, which is the same thing, in the same place of the civil calendar.

10. The most famous cycles are, the *cycle of the moon*, the *cycle of the sun*, and the *cycle of indiction.*

Illustration. 1. The cycle of the moon, or *lunar cycle*, called also the *Metonic* cycle, from its inventor, Meton of Athens, is a circle or revolution of nineteen years, in which time the new and full moons are supposed to return to the same day of the month in the Julian calendar.

2. The cycle of the sun, or *solar cycle*, is a revolution of twenty-eight years. When these are elapsed, the *Dominical* or Sunday letters, in the calendar, return into their former place, and proceed in the same order as before. It is from these *Sunday letters*, and not from any regard to the sun's course, that the cycle has obtained its name.

3. The *cycle of indiction* is a circle or revolution of fifteen years. This cycle has no relation to the celestial motions, but was made use of by the Romans to make known the time of paying certain taxes, or for other civil purposes. Ever since the time of Charlemagne, the popes have dated their bulls by the *year* of the *indiction*.

11. THE GOLDEN NUMBER. The *prime*, or *golden number*, is a revolution of nineteen years, and is that particular number which shows the year of the lunar cycle for any given year. Hence to find the year of the lunar cycle, is to find the golden number.

Observation. The numbers are called *golden*, because, being of excellent use, they were expressed in ancient calendars by figures of gold.

12. THE EPACTS. *Epacts* are *added num-*

bers; that is, a number of days added to the *lunar* year, to make it equal to the *solar* year.

Illustration. The solar year has 365 days, and almost six hours, and the lunar year 354 days, and upwards of eight hours. The *difference* is the *epact.* Now as this difference is not much short of eleven days, it was made the epact of the first year of the lunar cycle.

13. PERIODS OF TIME. A PERIOD is a series, or circle, of a certain number of years, used for measuring or computing time. Of these there are several, which take their names from the persons who invented them.

Illustration. 1. Of the *Metonic* period, or *lunar cycle* of 19 years, it is needless to say any thing more. It has been sufficiently explained in Illus. 1. art. 10.

2. The *Calippic* period, so called from its inventor, Calippus, is a series of 76 years, which being elapsed, Calippus supposed that the new and full moons would return to the same day of the solar year. This was intended as an improvement of the *Metonic* period.

3. The *Victorian* period of 532 years, arising from the cycles of the sun and moon multiplied into one another, was invented by Victorius, a French clergyman, about the middle of the fifth century, and was used by the western churches in computing the time of Easter, till the Gregorian reformation of the calendar.

4. The famous *Julian* period is a series of 7,980 years, arising from the multiplication of the cycles of the *sun, moon,* and *indiction* into one another, invented by Joseph Scaliger, adapted to the Julian year. It commences before the creation, and still wants about 1,500 years of being completed; all other cycles, periods, and epochas, and in short, the times of all actions and events, from the beginning of the world, are therefore comprehended within the Julian period.

14. EPOCHAS, or ERAS. An Epocha, or *Era,*

is a certain fixed point of time, made famous by some remarkable event, from whence, as from a root, the ensuing years are numbered or computed.

Illustration. 1. The *Christian epocha* is the common epocha throughout Europe, commencing on the 25th of December, or the first of January. In those countries which observe the Julian calendar, it commences on the 25th of March.

The author of this epocha (or way of computing from Christ) was Dionysius Exiguus, a Roman abbot, about the beginning of the sixth century.

2. The *epocha of the creation*, according to the Jewish computation, is the year of the *Julian* period 953, answering to the year of Christ 3,761, and commencing on the 7th of October. Hence, if we subtract 952 from any given year of the Julian period, the remainder is the corresponding year of the Jewish epocha of the creation.

3. The *epocha of the Olympiads*, which was used principally by the Greeks, is very famous in ancient history. It took its rise from the Olympic games, which were celebrated at the beginning of every fifth year, near Olympia, a city of Elis, in Peloponnesus. An Olympiad, therefore, was a period of four years; and by these periods, the Greeks reckoned their time, the year in which the games were celebrated being counted the first year of each Olympiad.

The beginning of the first *Olympiad* is referred to the year of the *Julian* period 3,938, or 776 years before Christ.

4. The *epocha of the building of Rome* was the principal one among the Romans. This epocha is the year of the Julian period 3,961, and answers to the year 752 before Christ, commencing on the 21st of April.

5. The *Dioclesian epocha*, or epocha of the *Martyrs*, commences in the year of Christ 284, and that of the

Julian period 4,997. It obtained its name from the great number of Christians who suffered martyrdom in the reign of the emperor Dioclesian.

6. The *epocha of the Hegira*, used by the Turks, Arabs, and others who profess the Mahometan faith, commences on the 16th of July, in the year of Christ 622, and of the Julian period 5,335. The word *Hegira* signifies *flight*, the event which gave occasion to this epocha being Mahomet's flight from *Mecca*.

15. A CENTURY, or an *age*, is a course of a hundred years.

16. A LUSTRUM is a space of five years, used by the Romans, at the end of which a review of the people was made, first by the kings, then by the consuls, but after the year 310 by the censors, who were magistrates created for that very purpose.

17. A JUBILEE is a periodical festivity, or public rejoicing on account of some remarkable event, or in memory of some eminent person.

Questions for Examination.

1. Define chronology and tell its uses.
2. What is time divided into?
3. Define a year generally, also a tropical, a siderial, a lunar, and a civil year.
4. What is meant by the reformation of the calendar?
5. What are the forms of civil years?
6. What are the principal divisions of months, as, astronomical, lunar, solar, and civil?

7, 8. What is said of weeks, days, and hours, and the time when different nations begin to reckon their day; and the division of days into hours?

9, 10. What is a cycle, and what are those famous cycles of the moon, the sun, and of indiction?

11, 12. What of the golden number, and of epacts.

13. What are periods of time? What are the Metonic, Calippic, Victorian, and Julian periods?

14. What are epochas or eras? Define the Christian epocha, the epocha of the creation, that of the Olympiads, that of the building of Rome, the Dioclesian, and the epocha of the Hegira.

15, 16, 17. Define a *century*, a *lustrum*, and a *jubilee*.

PROGRESS OF TIME.

INCESSANT down the stream of time,
And days, and years, and ages roll,
Speeding thro' Error's iron clime
To dark Oblivion's goal——
Lost in the gulph of night profound,
No eye to mark their shadowy bound,
Unless the deed of high renown,
The warlike chief's illustrious crown,
Shed o'er the darkling void of dubious fame,
And gild the passing hour with some immortal name!

Yet evanescent as the fleeting cloud
Driv'n by the wild winds o'er the varying skies,
Are all the glories of the great and proud,
On Rumour's idle breath that faintly rise;
A thousand garbs their forms assume,
Woven in vain Conjecture's loom,
Their dyes a thousand hues display,
Sporting in Fancy's fairy ray,
Changing with each uncertain blast,
Till melting from the eyes at last,
The shadowy vapours fly before the wind,
Sink into viewless air, "nor leave a wreck behind!"

PYE.

CHAPTER XXIV.

MYTHOLOGY.

1. *Introduction.* MYTHOLOGY, the religion of the Pagans, consisted in the belief and worship of false gods, the fictions of poets, painters, and statuaries, and to which different attributes were assigned.

Observation. Mythology is the basis of history, the standard of criticism, and the guide to the studies of youth, and a knowledge of it is absolutely necessary to the reader of the Classics, to the painter and the statuary.

Of the Celestial Deities.

2. CŒLUS and TERRA. CŒLUS was the son of the *Air*, great father of the gods, and husband of *Terra*, the daughter of the Earth, by whom he had the Cyclops, Oceanus, Titan, the Hundred Giants, and many other children, the most eminent of whom was *Saturn* or *Time*.

Observation. This fable signifies, that the Air and Earth were the common parents of all created beings.

3. SATURN. SATURN was the most ancient of all the gods.

Observation. 1. Titan, his elder brother, resigned his birth-right to him on condition that he should destroy all his male issue.

2. *Saturn* is represented as the emblem of *Time*, with a scythe in his hand; and during his reign, it is said, was the golden age of the earth, when the ground

yielded all sorts of fruits without culture, and *Astræa*, or *Justice*, dwelt among men, who lived together in perfect love and amity. He is said to have destroyed all his children, because *Time* devours all things.

4. CYBELE, accounted mother of the gods, was the wife of Saturn.

Observation. (1.) Her head is crowned with towers, because she is the goddess of cities, garrisons, and all things that the earth sustains.

(2.) In her hand she carries a key, because in winter the earth locks up her treasures, which in spring she unlooses and brings forth to dispense with a bountiful hand.

(3.) She is seated on a chariot, intimating that the earth hangs in the air, poised by its own weight. Her garments are painted with flowers of various colors, and figured with likenesses of several creatures.

5. JUPITER, the son of *Saturn* and *Cybele*, or *Ops*, is the father and king of gods and men. Homer has represented Jove sitting on a throne of ivory and gold, holding thunder in his right hand, and in his left a sceptre made of cypress, which wood, being free from corruption, is a symbol of eternal empire.

Observation. He was born and educated upon mount *Ida*, in Crete. Some say he was nursed by the *Nymphs*, and others that he was fed by the bees with honey.

6. JUNO, the queen of heaven, both the sister and wife of Jupiter, was born in the island of *Samos*, where she lived while she continued a virgin.

Observation. (1.) She is represented in a chariot drawn by peacocks, with a sceptre in her right hand, and a

crown on her head. She was mother of Vulcan, Mars, and Hebe.

(2.) *Iris*, her servant and peculiar messenger, because of her swiftness is painted with wings, sitting on a rainbow. It was her office to unloose the souls of dying women from the chains of the body.

7. APOLLO and SOL. APOLLO, the son of Jupiter and Latona, is represented as a beardless youth, with long hair, flowing over his shoulders, crowned with laurel, and shining in an embroidered vestment.

He is sometimes represented with a bow and arrows in his right hand, and a harp in his left. Sometimes he is seen with a shield in one hand, and the Graces on the other. By the invention of physic, music, poetry and rhetoric, he deservedly presided over the *Muses*.

SOL, who enlightened the world, is esteemed the same as *Apollo*.

8. MERCURY, the son of *Jupiter* and *Maia*, daughter of Atlas, was the god of eloquence and merchandize, and messenger of the gods.

Observation. (1.) He is represented as a young man, with a cheerful countenance, an honest look, and lively eyes; fair, without paint, with winged shoes and hat, and holding in his hand a winged rod, bound about with two serpents. He is said to have invented letters and the use of them. He excelled in eloquence and the faculty of speaking, and therefore was accounted the god of rhetoric and oratory.

(2.) His chief offices were, to carry the commands of Jupiter, to attend persons when dying, to unloose their souls from the chains of the body, and usher them into the world of spirits; likewise to revive, and replace into new bodies, those that had already completed their time in the Elysian fields.

9. MARS was the son of Jupiter and Juno.

Observation. (1.) He is the god of armies and war, fierce in aspect, stern in countenance, and terrible in dress. He sits in a chariot drawn by two horses, which are driven by a distracted woman. He is covered with armour, and brandishes a spear in his right hand. Sometimes he is represented sitting on horseback, formidable with his whip and spear, with a cock at his feet, the emblem of watchfulness.

His servants are *Fear* and *Terror*, *Discord* also goes before in a tattered garment, and *Clamour* and *Anger* follow him.

(2.) *Bellona*, goddess of war, is the companion and wife of Mars. She prepares for him his chariot and horses when he goes to battle.

10. BACCHUS, the son of *Jupiter* and *Semele*, has a red face, swoln cheeks, and prominent belly. He appears dispirited with luxury, and intoxicated with wine.

Observation. (1.) Bacchus first planted the vine and drank the juice of the grape. The tillage of the ground and making of honey are also attributed to him.

(2.) He is called *Liber*, and *Lyæus*, because wine frees the mind from cares, and those who have drank plentifully speak too often what comes into their minds.

11. MINERVA or *Pallas*, the goddess of wisdom, war, arts, and sciences, was the daughter of Jupiter; Vulcan struck his forehead with a hammer, and, after three months, he brought forth Minerva.

Observation. (1.) Her birth from *Jupiter's* head, is most certainly an emblem, that all human arts and sciences are the production of the mind of man, directed by superior wisdom.

(2.) Minerva is arrayed in armour; wears a golden head-piece, and on it glittering crests; a brazen coat of mail covers her breast; she brandishes a lance in her right hand, and in her left holds a shield, whereon is painted the grisly head of Medusa, one of the Gorgons, rough and formidable with snakes.

(3.) Upon the head of this goddess there was an olive crown, which is the symbol of peace; either because war is only made, that peace may follow; or because she taught men the use of that tree.

(4.) The cock and owl are sacred to Minerva; the first being expressive of courage and watchfulness, and the latter the emblem of caution and foresight.

12. VENUS, the daughter of *Jupiter* and *Dione*, is the goddess of beauty, neatness, and cheerfulness.

Observation. (1.) She is clothed with a purple mantle, glittering with diamonds, attended by two *Cupids.* The *Graces* stand round her, and the lovely Adonis follows after, gently holding up her train. Her chariot is of ivory, finely carved, beautifully painted and gilt, fashioned in the form of a shell, and drawn by swans, doves, and swallows, or sometimes by sparrows, as she directs, when she pleases to mount it.

(2.) The companions of Venus were, *Hymenæus* the god of marriage, and *Cupid* the god of love. She is called the *Lesbian Queen*, from *Lesbos*, in the island of Cyprus.

Questions for Examination.

1. Define mythology, and shew its usefulness.
2. Who were Cœlus and Terra?
3, 4. Give me all the particulars of Saturn and Cybele.
5, 6. And also of Jupiter and Juno.
7. Now describe Apollo and Sol; and tell me the attributes of each.

8. Who was Mercury? How is he represented? What are his offices?

9, 10. Give me now the particulars of Mars, Bellona, and Bacchus.

11, 12. Also all the particulars of Minerva and Venus.

2. *Terrestrial and Marine Deities.*

1. TITAN, the elder brother of *Saturn*, though not a god, claims the first place, being the elder son of *Cœlus* and *Terra*. On agreement with *Jupiter*, his younger brother, he yielded to him his birth-right. His sons were the *Giants*, called from him *Titans*.

2. VULCAN, the husband of *Venus*, was son of Jupiter and Juno; but being born deformed, he was cast down from heaven by Jupiter, as soon as he came into the world, and in the fall broke his leg. He was the god of subterraneous fires, and presided over metals.

Observation. (1.) He first paid his addresses to Minerva, and was refused by her. He afterwards married Venus, but that goddess disregarded him for his deformity.

(2.) Vulcan made the chariot of the Sun, and supplied Jupiter with thunder. He fixed his forges in Mount Ætna, but chiefly in the island of Lemnos, where he worked for the gods, and taught the natives the art of working iron by fire. His forgemen were the Cyclops, who are represented as having one eye only, in the middle of their forehead. Apollo, it is said, slew them all, for having forged the thunder with which Jupiter struck Æsculapius, the god of physic.

3. JANUS, the son of *Cœlus* and *Hecate*, had a double face and forehead in one and the same

head. Hence he got the name of the two-faced god, and was said to see things placetl behind his back as well as before his face. In his right hand he holds a key, and in his left a rod; and beneath his feet are twelve altars.

Observation. The temple of Janus, at Rome, was held in great veneration, and was kept open in the time of war, and shut in the time of peace. It is remarkable, that within the space of 700 years, this temple was shut only thrice; once by Numa; afterwards by the consuls *Marcus Attilius* and *Titus Manlius*, after a league concluded with the Carthaginians; and lastly by *Augustus*, after the victory of Actium.

4. LATONA, the daughter of Phœbe and Cœus the Titan, on account of her great beauty was beloved of Jupiter, by whom she had *Diana* and *Apollo*.

5. DIANA, goddess of hunting, the daughter of *Jupiter* and *Latona*, sister of *Apollo*, is usually painted in a hunting habit, with a bow in her hand, a quiver full of arrows hanging down from her shoulders, and her breast covered with the skin of a deer. She was the goddess of hunting and chastity.

Note. ACTEON, grandson of *Cadmus*, a famous hunter, intruding himself whilst Diana was bathing in a fountain, the goddess changed him into a stag, and he was devoured by his dogs.*

6. CERES, the daughter of *Saturn* and *Ops*, is represented as a lady, tall in stature, venera-

* Ovid.

ble with majesty, beautified with yellow hair, and crowned with a turban, composed of the ears of corn. She holds in her right hand a burning torch, and in her left a handful of poppies and ears of corn.

Observation. (1.) She first invented and taught the art of tilling the earth, of sowing pulse and corn, and of making bread; whereas before men only ate acorns.

(2.) *Ceres* is beautiful, because the earth, which she resembles, gives a very delightful and beautiful spectacle to beholders.

(3.) She holds a lighted torch, because when Proserpine was stolen away by Pluto, she lighted torches with the flames of Mount Ætna, and with them sought her daughter through the whole world.

(4.) Among various nations, the first fruits of the earth were offered to *Ceres*, as goddess of corn and agriculture.

7. NEPTUNE was the son of Saturn and Ops, and brother of Jupiter and Pluto; he received, in the division of his father's kingdom by Jupiter, the empire of the sea.

Observation. *Neptune* is esteemed governor of the sea, and father of the rivers and fountains. He is represented riding on the sea in a car, in the form of a shell, drawn by sea-horses, preceded by Tritons. He holds a trident in his right hand, as an emblem of his sovereignty, and is attended by the young Tritons and Sea Nymphs.

8. OCEANUS, a marine deity descended from Cœlus and Vesta, was called by the ancients, not only the father of rivers, but also of animals, and of the gods themselves.

9. THETIS, goddess of the sea, and wife of Oceanus, is said to have had many sons; the

chief of whom was Nereus, who dwelt in the *Ægean Sea*, and by his wife *Doris* had 50 daughters, called from him Nereides. Thetis is represented sitting in a chariot, in the form of a shell, drawn by dolphins.

10. AMPHITRITE, daughter of Oceanus and Doris, goddess of the sea, and wife of Neptune, is by the poets frequently taken for the sea itself.

11. TRITON, the son of *Neptune* and *Amphitrite*, was also his companion and trumpeter. In the upper part of his body he bears the resemblance of a man, and of a fish in the lower part. Most of the sea-gods from him are called Tritons.

12. The SYRENS, inhabitants of the sea, had faces of women, but the bodies of flying fish.

Observation. Their names were *Parthenope*, *Ligæa* and *Leucosia*. These dwelt near the coast of *Sicily*, and drew to them all passengers by the sweetness of their singing, and then devoured them.

Questions for Examination.

1. Who was Titan?
2. Give me the particulars of Vulcan, his marriage with Venus, and his trade.
3. Also those of Janus, and of his temple at Rome.
4, 5, 6. And those of Latona, Diana and Ceres.
7, 8. What is said of Neptune, and of Oceanus?
9, 10. Give me the particulars of Thetis, and Amphitrite.
11, 12. Also of Triton, and the Syrens.

3. *Of the Infernal Deities, Tartarus, and Elysium.*

1. PLUTO, the son of *Saturn* and *Rhea*, and brother of *Jupiter* and *Neptune*, received, in the division of his father's kingdom, the western parts, which gave rise to the poetical fable, that he was the god of hell.

Observation. He is called *Dis* by the Latins, and *Hades* by the Greeks, which last signifies *dark* and *gloomy*. He sits on a dark throne, holding a key instead of a sceptre, and wearing a crown of ebony. Sometimes he is crowned with a diadem, sometimes with cypress, and sometimes with daffodil, the flower that Proserpine was gathering, when he stole her away. His horses and chariot are of a black color, and himself is often painted with a rod in his hand for a sceptre, and covered with a head-piece.

2. PROSERPINE, queen of Hades, the infernal *Juno*, and wife of Pluto, was daughter of *Jupiter* and *Ceres*.

Observation. None of the goddesses would marry Pluto because of his deformity: being vexed that he was despised, and forced to live a single life, he in a rage mounted his chariot, and suddenly sprung up from a den in Sicily, amongst a company of very beautiful virgins, who were gathering flowers in the fields. Pluto, inflamed with the love of Proserpine, carried her off with him, and sunk into the earth, not far from Syracuse where immediately a lake arose.

3. PLUTUS, the god of riches, is blind, void of judgment, and timorous.

Observation. All these qualities denote some peculiar property of this god. He is blind, and void of judgment,

in the unequal distribution of riches, as he frequently passes by good men, whilst the wicked are loaded with wealth; and timorous, because the rich are constantly in fear, and watch over their treasures with great care and anxiety.

4. NOX, goddess of darkness, the most ancient of the goddesses, married the river *Erebus* in hell, by whom she had many daughters. *Nox* is painted in black robes, beset with stars.

5. CHARON, the son of *Erebus* and *Nox*, is the *ferryman* of hell.

Observation. He is represented by the poets as a terrible, grim, dirty old fellow. According to the fable, he attended with his boat, and for a small piece of money, carried over the river *Styx* the souls of the dead; yet not all promiscuously, but only those whose bodies were committed to the grave. The unburied shades wandered about the shores 100 years, and then were admitted into the boat, and ferried over the lake.

6. The TITANS, or GIANTS, were at first inhabitants of the earth; but, trusting to their great stature and strength, they waged war against Jupiter, and attempted to dethrone him from the possession of heaven.

Observation. In this battle they heaped up mountains upon mountains, and from thence darted burning trees into heaven. They hurled also prodigious stones and solid rocks, which falling again upon the earth, or in the sea, became mountains or islands. But being unsuccessful in the attempt, and destroyed by the thunder of Jupiter, with the assistance of the other gods, they were driven from the earth and cast into hell.

7. The FATES, three in number, were daughters of EREBUS and NOX. They preside over

time past, present, and to come. Their names are *Clotho, Lachesis* and *Atropos.*

Observation. Their office is to superintend the thread of life. *Clotho* holds the distaff, and draws the thread, *Lachesis* turns the spindle, and *Atropos* cuts the thread with her scissars: in other words, the first calls us into life, the second determines our lot and condition, and the third finishes our existence here.

8. The FURIES, or *Eumenides,* daughters of *Nox* and *Acheron,* were also three in number, namely Alecto, Megæra, and Tisiphone.

Observation. Their abode was in hell, to torment the wicked. They were armed with blazing torches, and surrounded with snakes, and other instruments of horror.

9. The HARPIES, or birds of prey, were also inhabitants of hell.

These were indifferently called *Furiæ, Ocypete, Lamiæ.* They were instruments in the hands of the gods to raise war in the world, and disturb the peace of mankind.

10. The infernal regions, the residence of *Pluto,* are represented as a subterraneous cavern, whither the souls of mortals descended, and were judged by *Minos, Æacus,* and *Rhadamanthus,* appointed by Pluto judges of hell. This place contained *Tartarus,* the abode of the unhappy; also *Elysium,* the abode of those that had lived well.

11. *Cerberus,* a dog with three heads, and covered with *serpents,* was door-keeper; he always waited at the infernal gate, to prevent mortals from entering, and the *manes* or shades from going out.

12. *Charon,* as before mentioned, was ferryman of hell,

and conducted the departed souls to the tribunal of *Minos*.

13. The rivers of hell were, ACHERON, STYX, COCYTUS, PHLEGETHON, and LETHE.

Observation. The waters of *Acheron* are extremely muddy and bitter. *Styx*, the principal river of hell, was held in so great veneration by the gods, that whoever broke the oath he had made by this river, was deprived of his divinity for 100 years. *Cocytus* is increased by the tears of the wicked, and flows with a lamentable noise, imitating the cries of the miserable. *Phlegethon* swells with fiery waves, and rolls streams of fire. The souls of the dead, having passed over these rivers, are carried into *Pluto's* palace. *Lethe* is the river of forgetfulness. If the ghosts of the dead drank the waters of this river, they lost the remembrance of all that had passed on earth.

14. Fable relates four remarkable punishments in Tartarus.

1. *Ixion*, for attempting to seduce *Juno*, was by Jupiter cast into hell, and condemned to be chained to a wheel which continually whirled round.

2. The *rebel Giants*, after their defeat by Jupiter, were punished in the severest manner, for their enormous crimes. The poets describe these monsters with *snakes* instead of *legs*.

3. *Tantalus* is represented as hanging over the waters, which are always flowing from him; and at the same time the finest fruit always touches his lips, which he is not permitted to taste. To this eternal torment of hunger and thirst he was condemned, for having invited the gods to a feast, when, to prove their *divinity*, he killed, boiled, and served up, as a repast for them, the joints of his son Pelops.

4. *Sisyphus*, the son of Æolus, is doomed to roll a huge round stone to the top of a mountain, whence it immediately descends, and makes his labor perpetual; a punishment allotted him, because he revealed the secrets of the gods. He was also a notorious robber.

Questions for Examination

1. What is said of Pluto; and his offices?
2. What also of Proserpine, and her marriage?
3, 4, 5. Give me all the particulars of Plutus, Nox, and Charon.
6. Also those of the Titans.
7, 8, 9. Now relate all you know of the Fates, the Furies, and the Harpies?
10, 11, 12. What is said of the infernal regions, of Cerberus, and Charon?
13. What also of the rivers Acheron, Styx, Cocytus, Phlegethon and Lethe?
14. What of the punishments of Ixion, the rebel Giants, Tantalus, and Sisyphus?

4. *The inferior Deities.*

The poets mention several deities of inferior note, styled *Dii Minores.*

1. ÆOLUS, god of the winds, tempests and hurricanes.

2. MOMUS, son of *Nox* and *Somnus*, was the god of jesting, banter, and folly. He is represented with a mask, and grotesque face. He was rather a jester, mocker, or mimic, of the gods, than a god himself.

3. MORPHEUS was the god of sleep.

4. PAN, son of *Mercury* and *Penelope*, was the god of the woods and shepherds. He is represented half man, and half goat, with a large pair of horns upon his head, a crook in one hand, and a pipe composed of reeds in the other.

5. SYLVANUS and FAUNUS were also gods of the forests, from whom were descended the other rural deities; as, *Satyrs*, *Sylvans*, *Fauns*, *Nymphs*, or *Dryades*, all inhabitants of the woods.

6. FLORA, the goddess of the spring and wife of

Zephyrus, is represented adorned with garlands, and near her is a basket of flowers.

7. POMONA presided over gardens, and orchards.

8. TERMINUS presided over the boundaries of lands.

9. PRIAPUS, son of *Venus* and *Bacchus*, drove away birds, and guarded the fruit trees.

10. CUPID, the god of love, and son of *Mars* and *Venus*, is represented as blind, with a bow in his hand, and a quiver of arrows on his shoulders, with which he wounds the hearts of lovers.

11. HYMENÆUS, or HYMEN, the god of marriage, is represented under the figure of a young man, holding a torch in his hand, with a crown of roses and sweet marjoram on his head.

12. The PENATES and LARES were also deemed gods. The first presided over provinces and kingdoms, and the latter over houses and particular families.

13. The GENII also were spirits, or deities, that presided over all persons and places.

14. ÆSCULAPIUS, son of Apollo, was the god of physic.

15. The CYCLOPS, four in number, and sons of *Neptune* and *Amphitrite*, were servants of *Vulcan*, and had only one eye, placed in the middle of their foreheads.

16. SILENUS, the foster father of *Bacchus*, and the god of *abstruse mysteries* and knowledge, is represented as a fat, old drunken fellow, riding on an ass.

17. The MUSES, daughters of Jupiter and Mnemosyne, goddess of memory, were the reputed goddesses of the several arts and sciences, and presided over the feasts and solemnities of the gods. They are represented young and very handsome, and are nine in number. Their names are CLIO, CALLIOPE, ERATO, THALIA, MELPOMENE, TERPSICHORE, EUTERPE, POLYHYMNIA, and URANIA. *Clio* presides over history, and is said to be the inventress of the lute. *Calliope*, so called from the sweetness of her voice, presides over eloquence and heroic poetry. *Erato*, or the *Lovely*, presides over lyric poetry. *Thalia* is the goddess of comedy; *Melpomene*,

of tragedy; and *Terpsichore*, or the *Jovial*, of dancing. *Euterpe* is so called because she imparts joy. She invented the flute, and presided over music. She is also said to be the patroness of logic. *Polyhymnia* is so called from her multiplicity of songs. She is said to excel in memory, and is the goddess of the ode. *Urania*, or the *celestial muse*, presided over *divine poesy*; and is said to be the inventress of astronomy.

The *Muses* are distinguished by masks, lyres, garlands, globes, and other emblems expressive of their different offices or accomplishments.

Pegasus, the famous horse of ancient fable, was an attendant on *Apollo* and the *Muses*.

18. The GRACES, called also *Charites*, were three sisters, daughters of *Jupiter* and *Eurynome*, or Venus. The first was named *Aglaia*, from her cheerfulness; the second *Thalia*, from her perpetual verdure; and the third *Euphrosyne*, from delight.

Observation. THEMIS, ASTRÆA, and NEMESIS, were three goddesses; the first of law and peace; the second of justice; and the third, a rewarder of virtue, and punisher of vice.

19. The EGYPTIAN DEITIES were *Osiris*, *Apis*, and *Serapis*, but these are different names of one and the same deity, son of Jupiter, by Niobe, and husband to Isis.

Observation. Their son ORUS was deemed, by the *Egyptians*, the *protector of the river Nile*, the *averter of Evils*, *Governor of the world*, and the *author of plenty*.

20. The PANTHEON: Both in Egypt and Rome, each deity had a temple, where the most solemn sacrifices were offered to them according to the prevailing notion of their power and influence.

21. The ORACLES of the ancients were deemed predictions and mysterious declarations of the will of the gods. The natural bent of man, to search into futurity, gave rise to this institution.

22. The SYBILLINE ORACLES were certain women,

whom the ancients believed to be endued with the gift of prophecy.

23. AUGURY, or the art of divination by birds, the meteors of the heavens, or the entrails of beasts, was held in the highest veneration by the idolatrous nations.

24. DEMI-GODS OR HEROES. The title of *hero* was given by the Greeks to those who had made themselves famous. A *demi-god* was a man descended of a god, or goddess, by a mortal; of which there were great numbers. Æneas, Ulysses, Hercules, Theseus, Achilles, and Jason, were the most celebrated.

Questions for Examination.

1, 2, 3. Who were Æolus, Momus, and Morpheus?

4, 5, 6. Who were Pan, Sylvanus, and Flora?

7, 8, 9. Who were Pomona, Terminus, and Priapus?

10, 11. Who were Cupid and Hymenæus?

12, 13. What were the Penates, the Lares and Genii?

14, 15, 16. Who were Æsculapius, the Cyclops, and Silenus?

17. Who were the Muses? What was the office of each of them? How were they distinguished? What of Pegasus?

18. Who were the Graces? And the goddesses of Law, Peace, and Virtue?

19, 20. Relate the particulars of the Egyptian deities, and of the Pantheon.

21, 22, 23. What is said of the Oracles, and of Augury?

24. And what of the demi-gods or heroes?

CHAPTER XXV.

Of Heraldry.

1. Heraldry is the science which teaches how to blazon, or explain in proper terms all that belongs to arms, and how to marshal, or dispose with regularity, divers arms on a field. It also teaches whatever relates to the marshalling of solemn processions, and other public ceremonies, at coronations, the installation of knights, the creation of peers, nuptials, christenings of princes, funerals, &c.

Illustration. Arms, sometimes called Coats of Arms, are hereditary marks of honor, made up of fixed and determined colours and figures granted by sovereign princes, as a reward for military valor, or some signal public service, and serve to denote the descent and alliance of the bearer; or to distinguish states, cities, societies, &c. civil, ecclesiastical and military.

2. Arms are distinguished by different names, to denote the causes of their bearing, such as *arms of dominion*, of *pretension*, of *concession*, of *community*, of *patronage*, of *family*, of *alliance*, of *succession*, and of *assumption*.

Illustration. (1.) *Arms of dominion* and *sovereignty* are those which emperors, kings, and sovereign states constantly bear; being, as it were, annexed to the territories, kingdoms, and provinces they possess. Thus, there are the arms of England, of France, of Spain, &c.

(2.) *Arms of pretension* are those of such kingdoms, provinces or territories, to which a prince or lord has some claim, and which he adds to his own, although such kingdoms or territories are possessed by another prince or lord.

(3.) *Arms of concession* or *augmentation* of honor, are either entire arms, or else one or more figures, given by princes, as a reward for some signal service. Thus, Lord Heathfield, who so gallantly defended Gibraltar, was permitted to assume that fortress on his escutcheon in addition to his family arms.

(4.) *Arms of community* are those of bishoprics, cities, universities, societies, companies, and other bodies corporate.

(5.) *Arms of patronage* are such as governors of provinces, lords of manors, patrons of benefices, &c. add to their family arms as a token of their superiority, rights, and jurisdiction. These arms have introduced into heraldry, castles, gates, wheels, ploughs, &c.

(6.) *Arms of family* or paternal arms, are those that belong to one particular family, and distinguish it from others; these it is criminal for any other person to assume, and punishable by the public authority.

(7.) *Arms of alliance*, are those which families and private persons take up and join to their own, to denote the alliance they have contracted by marriage. This kind of arms is either impaled or borne in an escutcheon of pretence, by those who have married heiresses.

(8.) *Arms of succession* are such as are to be taken up by those who inherit certain estates, manors, &c., either by will, *entail*, or *donation*, and which they either impale or quarter with their own; this multiplies the titles of some families from necessity, and not from *ostentation*, as many imagine.

(9.) *Arms of assumption*, or assumptive arms, are such as are taken up by the caprice or fancy of upstarts of mean extraction, who, on becoming persons of fortune, assume them without a legal title.

3. The essential and integral parts of arms, are, the *escutcheon*, the *tinctures*, the *charges*, the *ornaments*.

Illustration. The shield or escutcheon is the field or ground whereon are represented the figures that make up a coat of arms; for those marks of distinction were placed on bucklers, or shields before they were painted on banners, standards, flags, and coat-armour. For this reason the field or ground on which they are blazoned is called the shield or escutcheon.

4. Armorists distinguish nine different points in escutcheons, in order to determine exactly the position of the bearings they are charged with, as in the following figure:

A — the dexter chief,
B — precise middle chief,
C — sinister chief,
D — honor point,
E — fess point,
F — nombril point,
G — dexter base,
H — precise middle base,
I — sinister base.

The right side of the figure as A B H G or side opposite to the left hand of the person who looks on it, is the dexter side, and the other the sinister side, as C B H I.

5. That variable hue of arms which is common both to shields and their bearings, is called tincture, of which there are seven.

First, Yellow, called on the arms of princes, *Sol;* on those of peers, *Topaz;* and on those of commoners, *Or*, is expressed in engravings by dots as in the figure.

The second, WHITE, called on the arms of princes, *Luna;* of peers, *Pearl;* and of commoners *Argent*, is expressed by a plain white shield.

The third, RED, called on the arms of princes, *Mars;* of peers, *Ruby;* and of commoners *Gules*, is expressed by perpendicular lines, thus:

The fourth, BLUE, called on the arms of princes, *Jupiter;* of peers *Sapphire;* and of commoners *Azure*, is expressed by horizontal lines, thus:

The fifth, PURPLE, called on the arms of princes, *Mercury;* of peers, *Amethyst;* and of commoners, *Purpure*, is expressed by diagonal lines from the sinister chief to the dexter base, thus:

The sixth, GREEN, called on the arms of princes, *Venus;* of peers, *Emerald;* and of commoners, *Vert*, is represented by diagonal lines from the dexter chief to the sinister base, thus:

The seventh, BLACK, called on the arms of princes, *Saturn;* of peers, *Diamond;* and of commoners, *Sable*, is represented by perpendicular and horizontal lines crossing, thus:

There are other tinctures used in heraldry as ORANGE called *Tenny*, expressed by diagonal lines from the sinister-chief to the dexter-base points, traversed by horizontal lines.

And BLOOD COLOR *sanguine*, expressed by lines crossing each other diagonally from the sinister-chief to the dexter-base, and from the dexter-chief to the sinister-base.

Vegetables, &c. are represented on escutcheons in their natural colors.

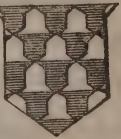
Roundlets are circular charges, which, if yellow, are called *Bezants;* if white, *Plates;* if blue, *Corts;* if red, *Torteux;* if green, *Pomeys:* if purple, *Golpes;* if sable, *Pellets;* if orange, *Orange;* if sanguine, *Gules.*

FURS represent the hairy skins of beasts, prepared for the doublings or linings, of robes or garments of state; and as shields were anciently covered with furred skins, they are therefore used in heraldry; they are *ermine, ermines, erminois, vair, pean,* and *potent.*

Ermine is a field argent, powdered with sable spots, their tails terminating in three hairs, thus:

Ermines are exactly like ermine except that the field is sable, the powdering white.

Erminois are like the two former, the field *or*, the powdering *sable*.



Vair is expressed by blue and white skins, cut into the form of small shields, ranged in rows opposite to each other, the base of the white ones being always next to that of the blue ones, thus :

Vair is usually of six rows, if there be more or fewer, the numbers must be expressed, and if the colors are different from those before mentioned, they must likewise be described.

Pean is the same as ermine ; the field *sable*, the powdering *or*.

Potent anciently called vairy cuppy, is when the field is filled with crutches or potents counterplaced ; it may be any two colors.

Of the lines used in parting Fields.

6. Escutcheons are either of one tincture or of more than one ; in those that are of one only, that is, when some metal, color, or fur is spread over that surface or field, such a tincture is said to be predominant ; but in such as have in them more than one, the field is divided by lines, which, according to their forms, receive diverse names.

Illustration. Lines may be either straight or crooked, straight lines are of four different kinds, viz. a perpendicular, | ; a horizontal, ——— ; a diagonal dex-

ter  ; a diagonal sinister  ; the different crooked lines are, 1. the engrailed  2. the inverted  ; 3. the wavy  ; 4. the nebulous  ; 5. the embattled or crenelle  ; 6. the raguly  ; 7. the indented  ; 8. the dancette  ; 9. the dovetail .

7. The principal reason why lines are thus used in heraldry, is to vary the bearings, which would be otherwise the same, for an escutcheon charged with a chief engrailed, differs from one charged with a chief wavy, as much as if the one bore a fess, and the other a bend.

Illustration. If the division consist of two equal parts made by the perpendicular line, it is said to be *parted per pale;* by the horizontal line, *parted per fess,* by the diagonal dexter, *parted per bend;* by the diagonal sinister, *parted per bend sinister.* If a field be divided into four equal parts by these lines, it is said to be *quartered;* and this may be done in two ways. 1. Quartered, or parted *per cross,* which is made by a perpendicular and horizontal line; these crossing each other at the centre of the field, divide it into four equal parts; 2. Quartered, or parted *per saltier,* by two diagonal lines, dexter and sinister, that cross as before in the centre of the field, and likewise divide it into four equal parts.

But in order to place in the field, the arms of the several families to which a person is allied, and which is

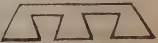
then called a genealogical achievement, these divisions sometimes consist of from six, to thirty, forty, or fifty quarterings, but so great a number is extremely inconvenient and indistinct.

Of the differences of Coats of Arms.

8. Armorists have invented many differences or characteristical marks whereby bearers of the same coats of arms are distinguished from each other, and their nearness of blood to the principal discovered.

These characteristical marks were anciently *bordures*, that is, a boundary going round the field, about one-sixth part of its breadth, and which may be either plain or engrailed, indented, &c.; they are sometimes used as marks of *illegitimacy*.

The modern differences that the English have adopted not only to distinguish sons of one family, but also to denote the differences and *subordinate* degrees in each house from the original ancestors are nine, viz.

For the heir, or the first son, the label, 

Second son, the crescent, 

Third son, the mullet, 

The fourth, the martlett, 

The fifth, the annulet, 

The sixth, fleur-de-lis, 

The seventh, the rose, 

The eight, the cross moline, 

The ninth, double quatrefoil, 

Illustration. Of all these marks of distinction the label only is affixed to the arms of the royal family. The arms belonging to the offspring of either of the above mentioned brothers are thus distinguished. The heir or first son of the second house bears a crescent, charged with a label during his father's life only ; the second son of the second house, a crescent charged with a crescent ; and the first son of the third house, a mullet charged with a label, and so on through the whole family.

2. An *abatement* is a casual mark attached to coat-armour, which announces some dishonorable act of the bearer. Abatements consist of diminution and reversing ; the first is the blemishing some particular point of the escutcheon by sanguine and tenny, which are stains ;

reversing signifies some parts of the charge turned backwards or upside down.

3. *Augmentations* are additional charges borne on an escutcheon, a canton, or crief, bestowed as particular marks of honor.

Of the Charges.

9. Whatsoever is contained in the field, whether it occupy the whole, or only a part thereof, is called a charge; all charges are distinguished by the name of honorable ordinaries, sub-ordinaries, and common charges.

Illustration. 1. *Honorable ordinaries,* the principal charges in heraldry, are made of lines only, which acording to their disposition and form, receive different names.

2. *Subordinaries* are ancient heraldic figures frequently used in coats of arms, and which are distinguished by terms appropriated to each of them.

3. *Common charges* are composed of natural, artificial, and even imaginary things, such as stars, animals, trees, ships, &c.

10. The most judicious armorists only admit of nine, namely, the chief, the pale, the bend, the bent sinister, the fess, the bar, the chevron, the cross, and the saltier.

1. The CHIEF is an ordinary bounded by a horizontal line, which, if it be of any other form but straight, must be described; it is placed in the upper part of the escutcheon, and contains one third of the field. Its diminutive is a *fillet*, which must not exced one fourth of the chief; this ordinance may be charged with a variety of figures, care

being taken, not in any case, to lay a metal on a metal, nor a color on a color. The diagram represents a *vert*, or *chief wavy or*.

2. The PALE is an ordinary formed by two perpendicular lines, drawn from the top to the base of the escutcheon, and contains a third part of the field. Its diminutives are, the *pallet*, which is the half of the pale, and the *endorse*, which is the half of the pallet; the *pale* and *pallet* may be charged, but the endorse must not. The diagram is *argent*, a *pale gules*.

3. The BEND is an ordinary formed by two diagonal lines drawn from the dexter chief to the sinister base, and contains the fifth part of the field if uncharged, and a third, if charged. Its diminutives are the *bendlet* or half the bend, the *cort* or cortice, the fourth of a bend; and the *ribband*, or eighth part of the bend. The diagram is a *bend purpure*.

4. A BEND sinister is the same as the bend, except being drawn the contrary way. The diminutives of this are a scrape, the half of the bend, and a baton, the half of the scrape, but this does not extend to the extremities of the field. The diagram represents a *gules*, a *baton or*.

5. The FESS is contained between two horizontal lines across the middle of the field of which it contains a third. The diagram represents an *argent*, a *fess sable*.

6. The BAR differs from the fess, only as it is but a fifth part of the shield. Its diminutives are, the *closet*,

half the bar; and the *bracelet*, half the closet. When the field contains an even number of bars of metal and color alternate, it is called *barry* of so many pieces, expressing their number.

7. The CHEVRON represents two rafters of a house, or a pair of open compasses; it takes up but a fifth part of the field. Its diminutives are the *chevronel*, half the chevron, and the *couple close*, half the chevronel. The diagram represents *ermine* a *chevron argent*.

8. The CROSS is an ordinary formed by the meeting of two perpendicular with two horizontal lines in the fess point, where they make right angles. The cross takes up only a fifth part of the field when uncharged, and a third when charged. There is a great variety of crosses in heraldry. The diagram represents *argent*, a *cross vert*.

9. The SALTIER is formed by the bend dexter and bend sinister crossing each other, like the cross, it contains a fifth part of the field if uncharged, and a third if charged. The diagram represents *or*, a *saltier azure*.

11. *Sub-ordinaries* are as follow, and are of worthy bearing, viz. the *gyron*, *franc-quarter*, *canton*, *pairle*, *fret*, *pile*, *orle*, *inescutcheon*, *tressure*, *annulet*, *flanches*, *flasques*, *voiders*, *billet*, *lozenge*, *guttés*, *fusil*, *rustre*, *mascle*, *papillone*, *diaper*.

1. The GYRONE is a triangular figure, formed by two lines, one drawn diagonally from one of the angles to the centre of the shield; the other horizontal or perpendicular from one of the sides, and meeting in the centre. Gyrony is when a field is covered with several gyrons. The diagram exhibits a *gyron azure*.

2. A CANTON is a square somewhat less than the francquarter; but without any fixed proportion, it generally possesses, the dexter corner of the shield, but should it possess the sinister corner, it must be blazoned by a canton sinister.

3. The PAIRLE is a figure formed of the upper half of the saltier with the under half of the pale resembling the letter Y.

4. The FRET is a figure representing a very narrow saltier, with a mascle in the centre interlaced: fretty is said when the field is covered with a fret of six, eight or more pieces. If there be less than eight pieces, their number must be specified, otherwise not.

5. The PILE consists of two lines terminating in a point in the form of a wedge. It issues in general from the chief towards the base, but some issue from other parts of the field.

6. The ORLE resembles the bordure, but is only one-half as broad.

The inescutcheon is a little escutcheon borne within the shield; that which is fixed on the fess point is called escutcheon of pretence, and is to contain the arms of of a wife who is an heiress.

7. A TRESSURE is an ordinary, half the breadth of an orle, which is generally borne fleury, and counter-fleury. The diagram represents *argent*, a *tressure argent*.

8. The ANNULET or ring is a well-known figure, and is frequently found in coats of arms of all nations.

9. FLANCHES are formed by two curved lines, or semicircles. Example : *or, flanches azure*.

Observation. 1. *Flasques* resemble flanches, except that the curved lines do not approach so near each other.

2. *Voiders* resemble flanches and flasques, but occupy less of the field.

3. The *billet* is an oblong square, twice as long as it is broad.

4. A *lozenge* is an ordinary resembling a diamond square.

5. *Guttés*, or drops, are round at the bottom, and terminate in a point at the top; they have different names according to their different tinctures, thus yellow are called *gouttes d'or* ; white, *d'eau* ; red, *de sang* ; blue, *de larmes* ; green, *de vert* ; black, *de poix*.

6. A *fusil* resembles a lozenge, except that it is much narrower.

7. The *rustre* is a lozenge pierced round in the middle.

8. The *mascle* is likewise a lozenge entirely void, except a narrow border.

9. The *papillone* is a field or charge covered with figures like the scales of a fish.

10. When a field or charge is shadowed with flourishing or foliage, with a colour a little darker than that on which it is wrought, and which only serves to embellish the coat, it is called a diaper.

11. If the forementioned ordinaries have any attributes, or a mark of distinction, that is, if they are *engrailed*, *indented*, *wavy*, &c., they are distinctly specified, after the same manner as the honorable ordinaries.

12. OF COMMON CHARGES—Some denote *glory*, *power*, *grandeur*, &c., others *courage*, *strength*, *prudence*, *swiftness*, &c., others the favorite pursuits of their owners, as *war*, *architecture*, &c.

Illustration. 1. The figures that denote glory, power, grandeur, &c. are the sun, moon, stars, comets, &c.

2. The symbols that denote courage, strength, prudence, swiftness, &c. are lions, tigers, serpents, stags, &c.

3. The figures war has furnished are lances, swords, battering-rams, portcullises, and a variety of other implements.

4. Creatures also of the imagination are frequently used in heraldry, such as *centaurs*, *hydras*, *dragons*, *wyverns*, *cockatrices*, *mermaids*, &c. &c.

5. Of the most honorable bearings, beasts are more honorable than fowls, and fowls than fishes; of animals the lion is the most honorable.

6. In common with their ordinaries, these bearings have various attributes or epithets, which express their qualities, positions, and dispositions.

7. Thus among the attributes which the heavenly bodies have—the sun is said to be *in his glory*, *eclipsed*, &c.; the moon *in her complement*, *increscent*, *decrescent*, &c. And among the attributes which animals have, a lion is said to be *rampant* when he stands erect on his hind legs, and *rampant-gardant* when in that position his head is turned sideways; *passant*, and *passant-gardant*,

when he is walking, *couchant* when he is lying down, &c. A stag when briskly walking, is said to be *tripping*; when running, *courant*; when standing still, at *gaze*, &c.

8. Birds are said to be *close*, when they stand with their wings shut; *rising*, when they lift them up for flight; *displayed*, when they spread themselves; and *volant*, when they are flying.

9. Fishes when swimming are said to be *naiant*; when perpendicular, *hauriant*.

10. Trees and plants are said to be *trunked*, *eradicated*, *fructuated*, or *raguled*, according as they are represented in arms.

11. Artificial figures have epithets expressive either of their position, disposition, or form; thus, swords are said to be, *erect*, *pommelled*, *hilted*, &c. arrows, *armed*, *feathered*, &c. towers, *covered*, *embattled*, &c. and so on of others.

Of the external Ornaments of Escutcheons.

13. The ornaments that accompany or surround escutcheons, were introduced to denote the birth, dignity, or office of the person to whom the arms appertain; they are used both by clergy and laity.

The most usual ornaments are *crowns*, *coronets*, *mitres*, *helmets*, *mantlings*, *chapeaux*, *wreaths*, *crests*, *scrolls*, and *supporters*.

Illustration. 1. Crowns are ornaments for the head, appropriated in the present day to emperors and kings only; the first crowns were only diadems, bands, or fillets.

Observation. Among the Greeks, the crowns given to those who gained the prizes at the Isthmian games, were of pine; at the Olympic, of laurel. The Romans had

various crowns to reward martial exploits and extraordinary services done the republic.

1. The *crown* of the king of Great Britain is a *circle of gold* bordered with *pearls* and *precious stones*, and heightened up with *four crosses pattee* and *four fleur-de-lis* alternately; from them rise *four arched diadems* adorned with pearls, which close under a mound surmounted by a cross like those on the circle.

2. *Coronets*, inferior crowns worn by princes and peers, denote their degree or rank. The coronet of the prince of Wales resembles the King's, except that it is closed with one arch only, adorned with pearls.

3. Besides the coronet, the prince has another distinguishing mark of honour peculiar to himself, viz. a plume of three ostrich feathers, with a *coronet of the ancient princes of Wales.*

Observation. The origin of the Prince of Wales's Plume is thus accounted for:—Edward the Black Prince, in the battle of Cressy, in 1346, having with his own hand killed the king of Bohemia, took from his head such a plume, and put it on his own.

4. The *coronet* of all the princes, the immediate sons and brothers of the king, is a circle of gold, bordered with ermine, heightened up with fleurs-de-lis and crosses pattee *alternately*.

5. *The coronet of the princesses* is a circle of gold, bordered with ermine, and heightened up with fleurs-de lis, crosses pattee, and strawberry leaves *alternately*.

6. A *duke's coronet* is a circle of gold, bordered with ermine, enriched with precious stones and pearls, and set round with eight large strawberry or parsley leaves.

7. *A marquis's coronet* is a circle of gold, with ermine, set round with four strawberry leaves and as many pearls on *pyramidical* points of equal height alternately.

8. *An earl's coronet* is a circle of gold, bordered with ermine, and heightened up with eight *pyramidical* points or rays, on the tops of which are as many large pearls, which are placed alternately with as many strawberry leaves, but the pearls much higher than the leaves :

9. *A viscount's coronet* is a circle of gold bordered with ermine, with pearls set close together on the rim without any limited number, which is his prerogative above the baron, who has his limited.

10. *The baron's coronet* was granted by King Charles the Second; six pearls are set at equal distances on a gold circle bordered with ermine, four only of which are seen in paintings, engravings, &c.

Observation. The eldest sons of peers above the degree of baron, use the coronet belonging to their father's second title, and bear his arms and supporters with a label, and all the younger sons bear the same arms with the proper difference, but without coronets.

11. *Caps of honor* worn by archbishops and bishops, and placed over their coats of arms instead of coronets, are called mitres.

12. The archbishop's mitre is a cap pointed and cleft at top, each top surmounted with a cross pattee; it is adorned with jewels, and issues out of a ducal coronet.

13. A bishop's mitre is precisely the same as the archbishop's, except that it has no ducal coronet. Mitres are not worn by English bishops, but are merely an appendage to their arms.

14. The helmet is worn as a defence, to cover the head and face, and is placed over the coat of arms as its chief ornament and the true mark of gentility.

Observation. Mantlings or flourishings are pieces of cloth jagged, or cut into fanciful forms, which serve as ornaments to escutcheons.

15. *The chapeau* is an ancient hat or cap of dignity, worn by dukes; the chapeau is generally of scarlet velvet on the outside, lined, and turned up with ermine; it is frequently painted above a helmet instead of a wreath, under noblemen's and gentlemen's crests.

16. *The wreath* is a kind of roll made of two skins of silk of different colours twisted together, which ancient

knights wore as a head-dress when equipped for tournaments.

17. *The crest* is the highest part of the ornaments of a coat of arms; it is called crest from the Latin word *Crista*, which signifies a comb or tuft, such as many birds have upon their heads, as the peacock, &c.

18. *The scroll* is an ornament usually placed below the shield and supporters, containing a motto or short sentence, alluding thereto, or to the bearing, or to the bearer's name.

19. *Supporters* are figures standing on the scroll, and placed at the sides of the escutcheon; they are so called because they seem to support or hold up the shield.

14. Blazoning is the deciphering or explaining the arms of families, and the following is an example of blazoning. Argent, a dragon's head erased, vert, holding in his mouth, a sinister hand couped at the wrist, gules.

Observation. Erased is a term used when the head or limb of any animal appears torn off by violence, so that the extremity is jagged and uneven.

Couped signifies a head or limb cut off, so that the extremity is smooth; it is also applied to such crosses, bars, bends, chevrons, &c. as do not touch the sides of the escutcheon, but are, as it were, cut off from them.

15. By marshalling coats of arms is to be understood, the art of disposing several of them in one escutcheon, and of distributing their *contingent* ornaments in their proper places.

Illustration. Various causes may be assigned why arms are thus conjoined. Thus when the coats of arms of a married couple, descended of distinct families, are to be marshalled on an escutcheon, the field of their

respective arms is conjoined palewise, and blazoned thus: parted per pale, baron and femme, husband and wife, first the baron's arms are to be described, then the femme's. The baron's arms are always to be placed on the dexter, and the femme's on the sinister side of the escutcheon. This is the case only when the femme is not an heiress.

Observation. Hatchments are funeral escutcheons, whereby may be known, after any person's decease, what rank he or she held while living; and if it is a gentleman's hatchment, whether he was a bachelor, married man, or widower, with the like distinctions for gentlewomen.

16. *Precedency* means the place of honor to which a person is entitled, as follows:

THE KING.

Princes of the Blood.
Archbishop of Canterbury.
Lord High Chancellor.
Archbishop of York.
Lord Treasurer.
Lord President of the Council.
Lord Privy Seal.
Dukes.
Eldest sons of Dukes of the Blood Royal.
Marquisses.
Eldest sons of Dukes.
Earls.
Marquisses' eldest Sons.
Dukes' youngest sons.
Viscounts.
Earls' eldest sons.
Marquisses' younger sons.
Bishops.
Barons.
Speaker of the House of Commons.
Lord Commissionerof the Great Seal.
Viscounts' eldest sons.

Earls' younger sons.
Barons' eldest sons.
Privy Counsellors not Peers.
Chancellor of the Exchequer.
Chancellor of the Duchy.
Knights of the Garter not Peers.
Lord Chief Justice of the King's Bench.
Master of the Rolls.
Lord Chief Justice of the Common Pleas.
Lord Chief Baron of the Exchequer.
Puisne Judges and Barons.
Knights Banneret, if made in the field of battle
Master in Chancery.
Viscounts' younger sons.
Barons' younger sons.
Baronets.
Knights Banneret.
Knights of the Bath.
Knights Bachelors.
Baronets' eldest sons.
Knights' eldest sons.
Baronets' younger sons.
Knights' younger sons.
Field and Flag Officers.
Doctors graduate.
Sergeants at Law.
Esquires.
Gentlemen.
Yeomen.
Tradesmen.
Artificers.
Laborers.

Ladies, except those of Archbishops, Bishops, and Judges, take place according to the quality of their husbands; and unmarried ladies take place according to that of their fathers.

This order is regulated by authority, and a breach of it renders the offender liable to an action at law.

Of the Military Orders.

17. Military orders are companies of Knights, instituted by Kings and Princes, either for the defence of religious faith, or to confer marks of honor, and make distinctions among their subjects.

The modern orders of Knighthood are merely honorary. There is scarcely a prince in Europe, that has not instituted one or more of these orders, for the purpose of rewarding meritorious services, whether of a military or civil nature.

The Orders of Knighthood in the United Kingdom are the order of the Garter, of the Bath, of St. Patrick, of St. Andrew or the Thistle, and Knights bachelors.

The Kings at arms are officers of great antiquity, and anciently of great authority, whose business it is to direct the heralds, preside at their chapters, and have the jurisdiction of armory. In England there are three, Garter, the principal Clarencieux, and Norroy, the two latter called provincial heralds.

Questions for Examination.

1. Define and illustrate Heraldry.
2. Why are arms distinguished? and what are arms of dominion, pretension, concession, community, patronage, family, alliance, succession, and assumption?
3. What are the essential and integral parts of arms?
4. What are the nine different points in escutcheons?
5. What are the meanings of the variable hues of arms, viz. yellow, white, red, blue, purple, green, black, orange, blood colour? What also do vegetables and furs mean on escutcheons?
6. What are the lines of parting fields?

7. Why are these lines used in heraldry?

8. What are the characteristical marks that indicate the differences of coats of arms?

9. Describe all the charges of arms.

10. Describe the chief, the pale, the bend, the bend sinister, the fess, the bar, the chevron, the cross, and the saltier.

11. Of subordinaries what are the gyron, the franc quarter, canton, pairle, &c.

12. Illustrate the common charges.

13. Among the external ornaments of escutcheons, define the crown, coronet, mitre, helmet, mantlings, chapeaux, wreaths, crests. scrolls, supporters.

14. Illustrate what is blazoning.

15. Also what marshalling is.

16. Describe the degrees of Precedency and the Military orders.

CHAPTER XXVI.

On the Construction of Maps.

The knowledge of Geography is acquired in two ways, from descriptions in words, and delineations or drawings.—The former is *Geography*, as that term is applied in books generally; the latter method is the representation of the globe of Earth, as a whole, or of particular portions of its surface, as Europe, Africa, Asia, and America.

Note. In this chapter we shall take for our authority "A Treatise on the Construction of Maps," by *Alexander Jamieson*. And we do this the rather, as the very brief epitome we shall here give cannot in any way interfere with that work, and as, from an Encyclopædia now publishing, down to the veriest child's book on Geography, every one who has had occasion to touch on the subject of Map-making has laid his hands on the Treatise in question.

The *construction of Maps* is termed Mathematical Geography, because it proceeds on the principles of the Mathematical sciences, *Geometry* and *Perspective*, with both of which the pupil is already acquainted, and, of course, fully prepared to enter upon the task to which we now call him; but we should rather say pleasure, for few subjects afford so many pleasures as drawing; and when it combines both knowledge and amusement, it carries in its train a two-fold delight. And as the success with which the

pupil's labors in this department of education will be crowned cannot be doubtful, we shall conduct him at once to its investigation.

In the construction of maps we have to delineate on a plane surface like this page of paper, what is originally depicted on a round ball or globe. But if you open an umbrella you will perceive that the cloth which covers it, tapers from the extreme edge till it terminates in a point at that part of the stick in which the ends of the ribs or whale bones are fixed. And, in like manner if you were to peel an orange according to its internal structure, it would represent a figure something like that shown by the umbrella. The seams of the cloth or the joinings of the several parts of the orange, indicate those stripes on the globes made by mapmakers, and which we call gores. All this is represented in figure 4. plate 2. of the Construction of Maps.

There are three methods of delineating a map; one is on *the plane of a meridian;* another on *the plane of the equator;* and the third is on *the horizon of some place.*

These three methods have given rise to three names for those three projections; and the first is called the *meridional;* the second, the *equatorial;* and the third, the *horizontal projection.*

But there are, besides, two ways of applying these projections; one is to delineations of the *one half* of the globe of the earth; and the other

is to *particular* portions of the earth's surface; as Europe.

Suppose you cut an apple through the middle with a knife, the flat surfaces made by the knife are *planes*. If you were to cut one of Cary's terrestrial globes with a saw by the equator, then you would have two *planes*, or flat surfaces. If the globe were of glass and all the lines and countries were drawn on it, and you could cut it in two by a diamond, would you not see those lines, &c. on the other side of the glass; that is to say, on the flat surface; (for I must suppose that when you cut it you laid a covering on the mouth of the bowl), you would, my friend; and the representation would be a perspective representation; for, from every part of the glass globular surface, rays of light would be coming to your eye through the flat glass covering; and if the various coloured rays could be detained on the flat surface, you would have a true perspective likeness of the globular surface. But then this perspective likeness will be different or variously distorted from the original picture, as your eye is nearer to, or removed from, the flat surface.

If your eye be removed from it a semi-diameter of the circle, the perspective picture is called the *stereographic projection*.

If your eye be removed to the distance of the chord line of 45° from the surface, or to the distance of a semi-diameter, added to the chord line of 45°, then the perspective picture is called the *globular projection*.

Note. The *Orthographic* projection is chiefly useful for astronomical purposes, and then only when you would represent a sign of the Zodiac. But it is obvious that twelve such projections, would furnish the means of depicting the twelve signs; and this is no inconsiderable advantage to those who study Astronomy.

PROBLEM I. On the plane of the equator, to project a map of the world, according to the

Plate 1.
to face page 239.

Globular Projection on the Plane of the Equator.

Fig. 1.

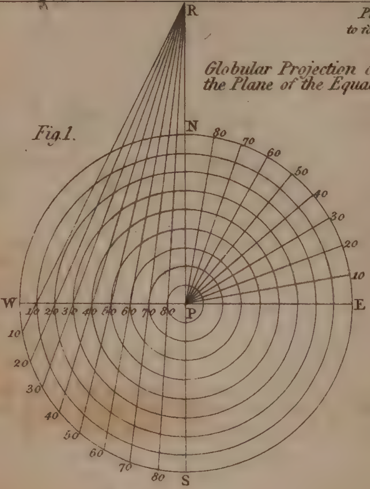
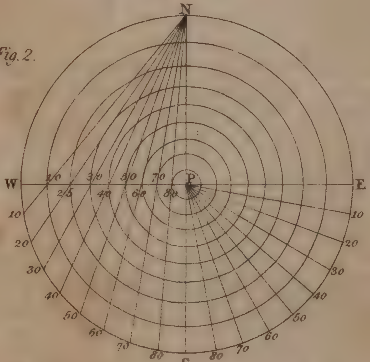


Fig. 2.



Stereographic Projection on the Plane of the Equator.

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globular projection of the sphere. (Fig. 1. plate i. Construction of Maps.)

The point P is the place of the eye, from whence the spectator, supposing the sphere pellucid, views the entire hemisphere N E S W. The lines which pass from 10, 20, 30, &c. in W S E to P, cross W P obliquely in the points 10, 20, 30, &c. Thus, the equal division, or nearly so, of the radius W P is obtained; and this is, in fact, the principle of the globular projection of the sphere, in which equal spaces on the globular surface are represented by nearly equal portions on the flat surface. R N is = the chord of 45° = rn.

1. To draw the meridians; which, in this map, are straight lines radiating from P, the pole. Divide the circumference into 36 or 360 equal parts, and to each of these equal divisions draw straight lines, and the meridians for one hemisphere will now be laid down.

2. To draw the parallels of latitude; which are concentric circles, described with their respective radii, from P the common centre.

We know that W P, the radius, is divided into nine equal parts. Then, with the respective radii, P 10, P 20, P 30, &c. describe the concentric circles, and one hemisphere is completed, so far as respects the projection of the meridians and parallels.

Countries, sea-coasts, towns or places, mountains, rivers, &c. are now to be laid down from Tables of Latitude and Longitude, and with the hand delineate all the minutiæ of the map.

PROB. II. To project a map of the world, on the plane of the equator, according to the stereographic projection of the sphere. (See Fig. 11. plate i.)

As the eye of the observer is, in this projection, placed on the surface of the sphere and in either pole, as at P, the straight lines drawn from the equal divisions of the quadrant W S to the point N, cut the radius W P into unequal divisions, and hence the principle of the stereographic projection of the sphere, *in which equal spaces on the surface of the earth are represented by unequal spaces on the projection*; the space W 10 being double of P 80; and, consequently, if P 80 be 1, W 10 will be 2; and any quadrilateral continued between W 10 and 10° of latitude, on a projection on the plane of the meridian, will be four times the size of a quadrilateral comprehended by P 80 and 10° of latitude, because the square of 2 is 4, and the square of 1 is 1.

1. To project the meridians; which, in this, as in the last Problem, are straight lines.

The directions given in that Problem apply perfectly to this, for the process is the same in both, and needs no further illustration.

2. To draw the parallels of latitude; which, as in the former projection, are concentric circles.

Take P as the common centre, and with the radii P 10, P 20, P 30, &c. respectively, describe the concentric circles, which shall represent the parallels.

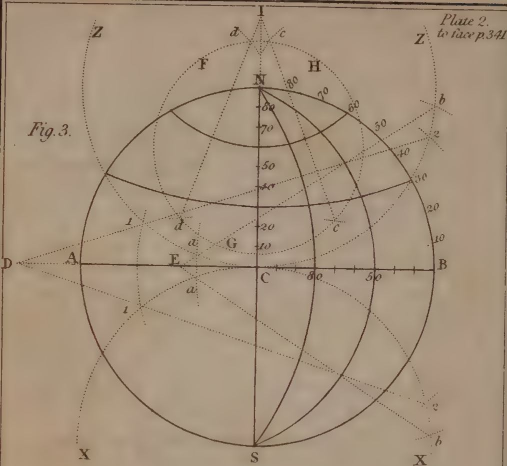
PROB. III. To construct a Map of the World, on the plane of a meridian, according to the globular projection of the sphere.—(See fig. 3. plate ii.)

Defin. 1. The *globular projection of the sphere* is that in which equal spaces on the surface of the globe of the Earth are represented by equal spaces of the projected map, as nearly as a spherical surface can be represented on a plane.

2. The *plane of a meridian* is the plane of one of the great circles of the sphere, passing through

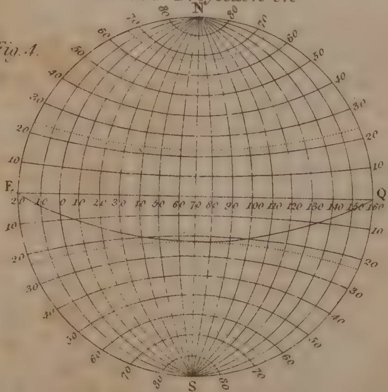
Plate 2. to face p.341

Fig. 3.



Globular Projection on

Fig. 4.



the Plane of a Meridian.

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both poles, and crossing the equator at right angles.

3. A hemispherical map of the world is a representation of the entire surface of the globe of Earth, projected on the plane of one of its great circles.

I. To draw *the meridians*, or *circles of longitude*.

1. Draw AB and NS at right angles to each other. A B represents the equator, and NS the *axis* meridian.

2. From C as a centre, with any radius, CA or CB, according to the size of your paper, describe the circle ANBS. This circle is then the plane of your projection.

3. Divide the four radii CA, CN, CB, CS, each into nine equal parts.

4. Now, to draw the meridian 80° west of Greenwich, we have the two poles N, S, and the point 80° in the equator, or diameter AB.

5. From N as a centre, and with NC as a radius, describe the arc ZCZ ; also from S, with the same radius, describe the arc XCX.

6. Then remove the compasses to the point 80 on the equator, and describe the arcs 1, 1, and 2, 2.

7. Through the intersections, as at 1 and 2, draw lines from 2, 2, through the points 1, 1, till they intersect the diameter BA produced in D.

8. Then will D be the centre from which, with the radius D 80, or DN, or DS, the meridian of 80° west longitude from Greenwich must be described.

Note.—The same radius will draw the meridian 140° W. L. ; and in the other hemisphere, the corresponding meridians of east longitude.

9. The meridian of 50° is drawn in the same manner as that of 80°, except that the point 50 on the equator (AB) is the centre from which, with the radius CB, the intersections are made at *a,a* and *b,b* on the arcs de-

scribed from N and S. The point E, where the lines *b a*, *b a*, meet on the equator, is the centre for the meridian of 50° W. Long. The same radius serves for the other three meridians 30° within the circle of projection. And in this manner are all the other meridians for both hemispheres to be drawn.

II. *To draw the parallels of latitude.*

1. The same construction remaining, and the radii CN, CS, divided each into nine equal parts. Divide the circumference ANBS into 36 equal parts; so shall each quadrant AN, NB; BS, SA, be divided into nine equal parts, which, being again subdivided into ten equal parts each, will give us 360 equal parts or degrees.

2. To draw, now, the parallel of 60° *north* latitude, set one foot of the compasses in the point 60 on the *axis* meridian NS, and with any radius describe the circle FGH.

3. Set, again, one foot of the compasses in the points 60, 60, in the circumference, and intersect the circle FGH in the points *dd*, *cc*.

4. Through *cc* and *dd* draw the straight lines *cc*, *dd*, meeting each other in the point I of the axis SN, produced to I.

5. With I as a centre, and I 60 as a radius, describe now the parallel of 60° north latitude. The same radius is, of course, used for 60° south latitude.

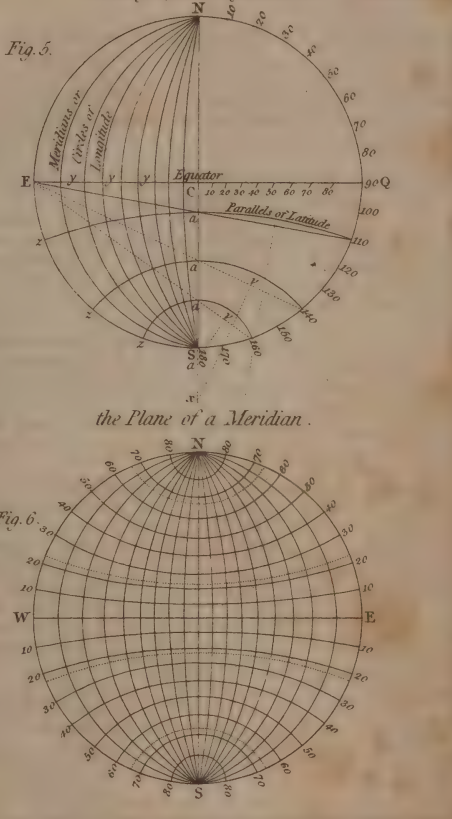
6. After the same process the parallel of 30° north latitude is drawn, as may be easily conceived by inspecting the figure. And in this way proceed with all the other parallels in both hemispheres.

Figure 4 represents this projection completed, so far as regards the lines to be drawn for the purposes of delineating countries, and the solution of problems.

PROB. IV. To project a map of the world on the plane of a meridian, according to the *stereo-*

Plate 3.
to face page 342.

Stereographic Projection on the Plane of a Meridian.



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graphic projection of the sphere.—Fig. 5. plate iii.

I. *To draw the circles of latitude.*

1. Describe, from any centre C, the circle ENQS which will represent one half of the earth's surface.

2. Draw the diameters EQ and NS, intersecting each other at right angles.

3. EQ will be the equator, and NS the axis meridian.

4. Divide the circumference into 360 equal parts; numbered 10, 20, 30, &c. as on the figure.

6. From E to 140 draw the line E 140; bisect the portion *a* 140 in *v*, and from *v* raise the perpendicular *v x*; which produce till it meet NS produced in *x*. The point *x* will now be the centre from which to describe the parallel *z a* 140; or, which is the same thing, the 50th degree of *south* latitude.

The same radius will serve for the 50th parallel of *north* latitude; and after the same manner all the other parallels in both hemispheres are drawn, as they are fully shown in figure 6th, plate iii.

II. *To draw the circles of longitude.*

1. The unequal divisions of the equator, as indicated by the numbers 10, 20, 30, &c. on the radius CQ, are obtained by the process given in Problem ii. Fig. 2.

2. The points 20, 40, 60, 80, will now be centres on which the circles of longitude S *y* N are to be drawn; but, for the remaining circles, produce the diameter EQ, and from N, through every tenth degree in the quadrant NQ, draw lines cutting that diameter produced, and the points of intersection will give the centres for the remaining circles of longitude: it is necessary, however, to observe that each centre is twenty degrees distant from the preceding one.

3. For the circles of longitude in the other semi-hemisphere, the centres may be formed by setting off the proper distances on the diameter EQ, produced the contrary way.

Figure 6th represents the projection completed.

PROB. V. To project a map of the earth according to the horizontal stereographic projection of the sphere, and answering to the latitude of London, (See Fig. 7. plate 4. No. 1.)

I. *To draw the meridians.*

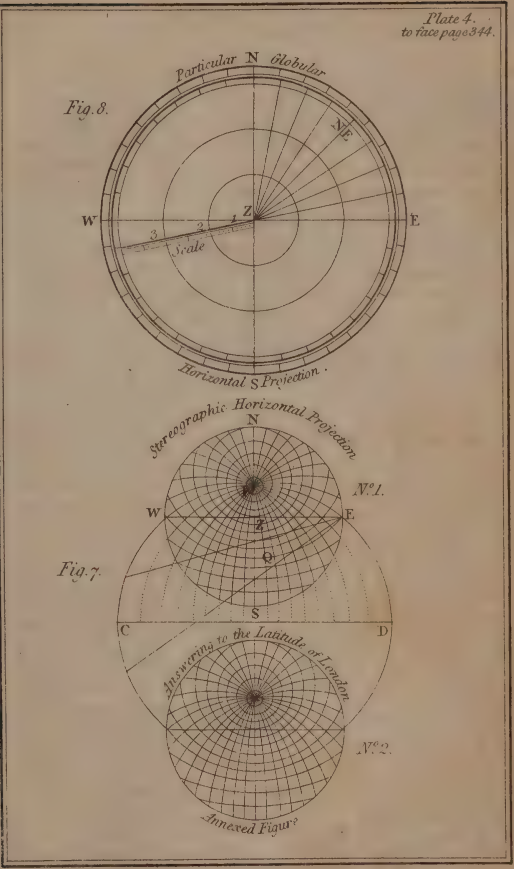
1. With any radius, SC or SD, describe the circle C PD, which divide as usual into 360°, and draw CD, PS, at right angles to each other; then will PS be the first meridian, or the north and south *azimuth.*

Note. Azimuth or *vertical circles*, are great circles of the sphere intersecting each other in the zenith and nadir, and cutting the horizon at right angles.

2. On the quadrant DP set off DE = $51\frac{1}{2}$° = the latitude of London, and draw parallel to CD, WE, the east and west *azimuth* of the place. Bisect WE in the point Z, which will be *London*, or *the place of projection.* The letters E, S, W, N, represent the four cardinal points, bearing due east, west, north and south, from London (Z), as the centre of the projection. And P, the pole of the meridional, is also the pole of the horizontal projection.

3. *To describe the meridians of the meridional projection* CPD, we must allow them to pass through the pole P, beyond the primitive circle, and touch the horizontal projection in the segment W N E.

4. *To describe the parallels of latitude,* we lay a ruler upon W, and move it to every degree, or every tenth degree of the meridian PD continued, marking where it cuts the meridian NS, because through these points the parallels on this side of the pole must all pass. But, as they have not a common centre, the points through which they pass on the other side of the pole are found by moving the ruler along every tenth degree of the meridian PC continued; for, wherever the ruler intersects the meridian NS, there will be the opposite points through which the parallels are to pass.



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5. Having now got all the diameters of the parallels, we have only to bisect each of them, and with one half, as a radius, describe the correspondent parallel. In fine, the projection is now to be completed, as shown in the annexed Figure, No. 2.

PROB. VI. By the globular projection of the sphere, to construct a map with *azimuth* lines, to show the *bearing* and *distance* of all places within the map, from London, or any other given place, in the centre. (See Fig. 8. plate 4.)

It will be perceived that, in this partial projection, the longitudes and latitudes of places are neglected, because the map is restricted to the bearing and distance only of places from a station in the centre.

1. Having described a circle of any convenient radius, we cross it with two diameters; of which NS represents the meridian of the place assumed as the centre, or the north and south line; and WE, the east and west line, may be considered the parallel of latitude passing over the place. The intersection of the diameters, as at Z, indicates the place in the centre.

2. Divide each quadrant into 90°, as shown in the exterior circle of the Figure; and the whole inner circle into 32 equal parts, to indicate the points of the mariner's compass. The lines radiating from Z are the bearing lines. The three concentric circles, described from the common centre Z, are assumed as one degree each; and the scale contains 180 geographical, or 208½ English miles.

3. Suppose, now, we place *London* in the centre; then, by the help of the Tables of latitude and longitude we may transfer into this projection all places within 180 miles of London.

The numbers 1, 2, 3, degrees, on the scale from the centre, are arbitrary, and may be reckoned 10, 20, 30 degrees; in which case, our projection would embrace 1800 geographical, or 2085 English, miles. Or, if the

radius, or scale, be divided into 4, 5, 6, or any given number of equal parts, each of those parts may represent 4, 5, 6, or 40, 50, 60, degrees.

The scale in this projection must be considered a moveable slip of Bristol board, graduated according to the radius of the projection, and riveted on the map by means of a neat button. Its use is obvious; for, by moving it round, we determine the bearing and distance of all places from London, or any other place (Z), in the centre.

PROB. VII. To construct Mercator's chart of the World. Fig. 9. Plate 5.

1. Draw any indefinite line for an equator, marked EQUATOR, as in the plate.

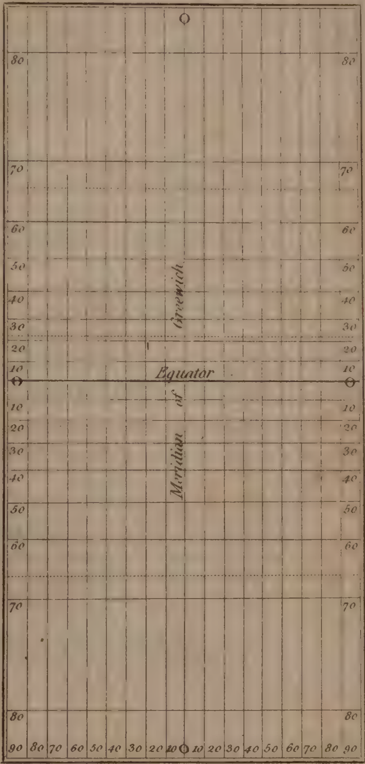
2. Assume any point on this line for the position of the *first* meridian; that is to say, the *Meridian of Greenwich.*

3. Take any assumed distance in the compasses for 10° of longitude, or the unity of measure; set this off on the equator from *zero* (o), or the meridian of Greenwich, eighteen times on both sides of *zero*. Then will 360° of longitude be set off; because $18+18=36$, which, multiplied by 10°, give 360°.

4. Through those 36 equal divisions on the equator draw at right angles to the equator straight and parallel lines, which will be the meridians 0, 10, 20, 30, &c. and which on the projection are continued across the chart at every 10th degree of longitude, east and west of *zero*, or Greenwich.

Plate 5.
to face page 346.

Fig. 9. Mercators Projection.



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A TABLE OF MERIDIONAL PARTS,

For the Construction of Mercator's Chart.

Deg.	Mer. Pts.	Deg.	Mer. Pts.	Deg.	Mer. Pts.	Deg.	Mer. Pts.	Deg.	Mer. Pts.
1	60	17	1035	33	2100	49	3382	65	5179
2	120	18	1098	34	2173	50	3474	66	5324
3	180	19	1161	35	2264	51	3569	67	5474
4	240	20	1225	36	2318	52	3665	68	5631
5	300	21	1289	37	2393	53	3764	69	5795
6	361	22	1354	38	2468	54	3865	70	5966
7	421	23	1419	39	2545	55	3968	71	6146
8	482	24	1484	40	2623	56	4074	72	6335
9	542	25	1550	41	2702	57	4183	73	6534
10	603	26	1616	42	2782	58	4294	74	6746
11	664	27	1684	43	2863	59	4409	75	6970
12	725	28	1751	44	2946	60	4527	76	7210
13	787	29	1819	45	3030	61	4649	77	7467
14	848	30	1888	46	3116	62	4775	78	7745
15	910	31	1958	47	3203	63	4905	79	8046
16	973	32	2029	48	3292	64	5039	80	8375

5. To lay down the parallels of latitude of this Mercator's chart, look in the foregoing Table of Meridional parts for the number of parts corresponding to 10° of latitude. They are 603; divide this 603 by 60, and the quotient 10.3 will be 10 *degrees* 3 *minutes*, because the 603 parts are *minutes*; and the divisor 60 is also 60 minutes, or 1 degree. Take, then, 10° 3′ from the degrees of longitude on the equator, and set them off, both north and south, from the *zeros* 0,0, at the extremities of the equatorial line; and draw the parallels of 10° north and south latitude.

6. To lay down the parallel of 20° north or south latitude, divide by 60 the meridional parts answering to 20°,—viz. 1225,—and the quotient 20° 25, taken from the degrees of longitude on the equator, and set off both ways from the point *zero*, will give the exact position of the 20th degree of north and south latitude.

7. The latitude of 30° is $1838' \div 60' = 31° 20'$ taken from the equator, and set off both ways from the *zeros*.

8. That of 40° is $2623' \div 60' = 43° 43'$ taken from the equator, and set off both ways from the points *zero*.

9. That of 50° $= 3474' \div 60' = 57° 54'$ taken from the equator, and set off both ways from the points *zero*.

10. That of 60° $= 4527' \div 60' = 75° 27'$, &c.

The places in this map are to be laid down according to their latitude and longitude; and the sea-coast neatly delineated with the black-lead pencil. Wherever rocks, shoals, anchorages, bays, promontories, capes, headlands, &c. occur, they must be carefully laid down. The interior part of the map is neglected, and the sea-coast alone attended to with scrupulous exactness in general.

In filling up any map, all placcs representing land are filled with such things as the countries

contain; but the seas are left white, the shores being shaded. Rivers are marked by strong lines, or by double lines, drawn winding in form of the rivers they represent; and small rivers are expressed by small lines. Different countries, are best distinguished by different colours, or at least the borders of them. Forests are represented by trees; and mountains shaded, to make them appear. Sands are denoted by small points or specks, and rocks under water by a small cross.

TO DRAW A MAP OF ANY PARTICULAR COUNTRY.

PROB. VIII. 1*st Method.* For this purpose, the extent of the country must be known as to latitude and longitude. Suppose you want to draw a map of France, which extends from 42° to 52° N. L. and from 4° W. to 12° E. L.; so that its extent from north to south is 10°, and from east to west 16°.

Draw the line AB (fig. 10), for a meridian passing through the middle of the country; on which set off 10° from B to A, taken from a convenient scale. A being the north, and B the south point; through A and B draw the perpendiculars CD, EF, for the extreme parallels of latitude: divide AB into 10 parts, through which draw the other parallels of latitude parallel to the former.

For the meridians, divide any degree in AB into 70 parts, or English miles; then, because the length of a degree in each parallel decreases towards the pole, take from *the table* (page 352) *containing the length of a*

degree of longitude in English miles for every degree of latitude, the number of miles answering to the latitude of B (here 42°), which is 52½ nearly, and set it off 8 times each way from B towards E and F;—so is EF divided into degrees. Again, from the same table, take the number of miles of a degree in the latitude A (52°), which is 42½, and set it off both ways from A towards C and D: then, from the points of division in the line CD, to the corresponding points in the line EF, draw so many right lines for the meridians: number the degrees of latitude up both sides of the map, and the degrees of longitude on the top and bottom: also, in some vacant place, make a scale for miles, by dividing 1 degree into 70 parts, to serve for finding the distances of places upon the map.

Having the latitudes and longitudes of the principal places, it will be easy to set them down in the map; for any town must be placed where the circles of its latitude and longitude intersect: for instance, Calais, whose latitude is 50° 57′ N. and longitude 1° 51′ E. will be at C; and Paris, whose latitude is 48° 50′ N. and longitude 2° 20′ E. will be at P.

The sea-coast may be described by setting down the capes and principal places situated upon it, and then drawing a continued line through them all. In the same manner rivers are delineated, by setting down the towns, &c. by which they pass.

2d Method. A map of Europe, or of any other quarter of the globe, may be drawn in the same manner as the whole is drawn; but in partial maps an easier way is as follows:

Having drawn the meridian AB (fig. 10), and divided it into equal parts, as in the last method, through all the points of division draw lines perpendicular to AB for the parallels of latitude; CD, EF, being the extreme parallels: then, to divide these, set off the degrees in each parallel, diminished after the manner directed

Plate 6. to face page 350.

Fig. 10. *Projection of a Map of France.*

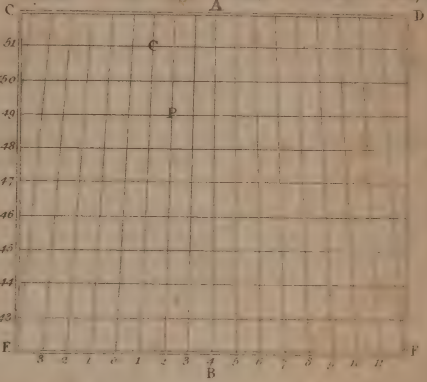
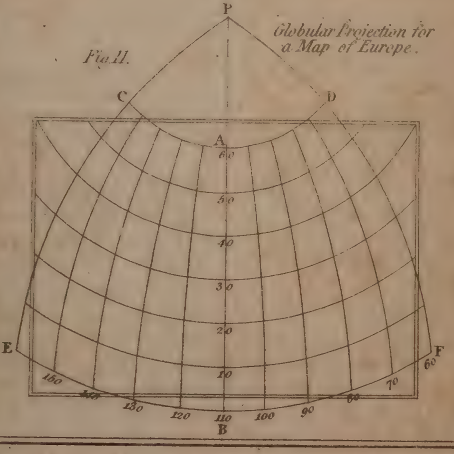


Fig. 11. *Globular Projection for a Map of Europe.*



for the two extreme parallels CD, EF, in the last method; and through all the corresponding points draw the meridians, which will be *curve* lines, and not straight lines, as they were in the last method.

This method is proper for a large tract of country, and may also do for a map of Europe; in which case the meridians and parallels need only be drawn to every 5 or 10 degrees.

This method is much used in drawing maps, as all the parts are nearly of their due magnitude, but a little distorted towards the outside, from the oblique intersection of the meridians and parallels.

3d *Method.* For drawing a large map, suppose North America,—draw PB (fig. 11) of any convenient length, for a meridian; divide it into 9 equal parts, and through the points of division describe as many circles for the parallels of latitude, from the centre P, which represents the pole.

Suppose AB the height of the map; then CD will be the parallel passing through the greatest latitude, and E F will represent the equator.

Divide the equator into equal parts of the same size as those in AB, both ways, beginning at B.

Divide also all the parallels into the same number of equal parts, but less in proportion to the latitudes, as directed in the last method for the rectilineal parallels:

Then, through all the corresponding divisions, draw curve lines, which will represent the meridians, the extreme ones being EC and FD.

Lastly, number the degrees of latitude and longitude, and place a scale of equal parts, either of miles or degrees, for measuring distances.

If one of the meridians, in a vacant part of the map, be graduated or divided into degress, it will serve for measuring distances, and also for the more accurately determining of the latitude of places.

This is a very good way of drawing large maps, and is called the *globular projection*,—all parts of the earth being represented nearly of their due magnitude, excepting that they are a little distorted on the outside.

TABLE

OF THE

LATITUDES AND LONGITUDES

OF THE

PRINCIPAL PLACES

THAT ARE INSERTED IN MAPS.

Names of Places.	*Sea or Country.*	*Latitude.*	*Longitude.*
Abbeville	France	50° 7′N	1° 50′ E
Aberdeen	Scotland	57 5 N	2 21 W
Acapulco	Mexico	17 30 N	101 45 W
Achem	Sumatra	5 22 N	95 34 E
Acre	Syria	32 49 N	35 15 E
Adrianople	Turkey	44 5 N	26 31 E
Adventure (B.)	New Holland	43 23 S	147 30 E
Adventure (I.)	Pacific Ocean	17 5 S	144 8 W
Agadez	Africa	20 3 N	11 58 E
Agen	France	44 12 N	0 36 E
St. Agnes (Lights)	Scillies	49 56 N	6 46 W
Agra	India	27 10 N	78 0 E
Aire	France	43 42 N	4 56 E
Aix	France	43 32 N	5 26 E
Aix-la-Chapelle	France	50 47 N	6 4 E
Alashka (St. Pt.)	North America	54 45 N	163 11 W
Alby	France	45 56 N	2 8 E

Names of Places.	*Sea or Country.*	*Latitude.*		*Longitude.*	
Alençon	France	48°	28′ N	0°	6′ E
Aleppo	Syria	35	45 N	37	20 E
Alexandria	Egypt	31	11 N	30	16 E
Algiers	Barbary	36	49 N	2	13 E
Alkmaar	Holland	52	38 N	4	37 E
Allahabad (Ft.)	India	25	27 N	81	52 E
Altdorf	Switzerland	46	50 N	8	36 E
Altorf	Germany	49	17 N	11	11 E
Amboyna (I.)	India	4	25 N	127	25 E
Ambrym (I.)	Pacific Ocean	16	9 S	168	12 E
Amiens	France	49	54 N	2	18 E
Amsterdam (I.)	Pacific Ocean	21	9 S	174	46W
Anabona (I.)	Atlantic Ocean	2	36 S	5	35 E
Anapolis Royal	North America	44	52 N	64	0W
Andrew's (St.)	Scotland	56	17 N	2	58W
Angers	France	47	28 N	0	33W
Angoulême	France	45	39 N	0	10 E
Anspach	Germany	49	19 N	10	34 E
Antibes	France	43	35 N	7	7 E
Antigua	Caribbean Sea	17	4 N	62	9W
Antioch	Syria	36	11 N	36	32 E
Aracan	India	20	3 N	93	30 E
Aracta	Asia	36	1 N	38	50 E
Arcot	India	12	57 N	79	33 E
Arles	France	43	40 N	4	37 E
Arras	France	50	18 N	2	45 E
Ascension (I.)	South Atlantic	7	56 S	13	59W
Astracan	Siberia	46	28 N	47	58 E
Augsburg	Germany	48	16 N	10	52 E
St. Augustine (C.)	America	4	48 S	35	5W
Aurora (I.)	Pacific Ocean	15	8 S	168	17 E
Ava	Asia	22	5 N	97	45 E
Avignon	France	43	57 N	4	48 E
Awatcha	Asia	53	1 N	158	30 E
Azoff	Europe	47	10 N	40	55 E
Babelmandel (I.)	Red Sea	12	50 N	43	45 E
Babylon	Asia	32	25 N	44	29 E
Bagdad	Asia	33	20 N	44	24 E

Names of Places.	*Sea or Country.*	*Latitude.*		*Longitude.*	
Balasore	Asia	21°	20′ N	86°	0′ E
Bahama (I.)	Atlantic Ocean	26	45 N	78	35 W
Bangalore	India	13	0 N	77	42 E
Bantam	Java (I.)	6	15 S	106	25 E
Barbadoes (I.)	Atlantic Ocean	13	0 N	59	50 W
Barbuda (I.)	Atlantic Ocean	17	50 N	61	50 W
Barnevelt's (I.)	America	55	49 S	66	58 W
Basil	Switzerland	47	35 N	7	29 E
Basse Terre	Guadaloupe	15	59 N	61	54 W
Bassora	Asia	30	31 N	47	32 E
Batavia	Java (I.)	6	11 S	107	52 E
Bath	England	51	22 N	2	21 W
Bayeux	France	49	17 N	0	43 W
Bear Island	America	54	34 N	79	56 W
Beauvais	France	49	26 N	2	5 E
Belgrade	Turkey	45	3 N	21	27 E
Belle Isle	France	47	17 N	3	5 W
Benares	India	25	18 N	83	0 E
Bencoolen	India	3	49 S	102	9 E
Bengal	India	22	0 N	92	45 E
Berlin	Prussia	52	31 N	13	22 E
Berne	Switzerland	46	58 N	7	31 E
Berwick	Britain	55	47 N	2	5 W
Besançon	France	47	14 N	6	3 E
Cape Blanco	Africa	20	55 N	17	10 W
Cape Blanco	Peru	4	15 S	81	0 W
Bolabola	Pacific Ocean	16	32 S	151	52 W
Bologna	Italy	44	30 N	11	21 E
Bombay	India	18	57 N	72	54 E
Borneo	China Sea	5	3 N	114	20 E
Boston	America	42	25 N	70	59 W
Botany Bay	New Holland	34	0 S	151	21 E
Bourbon Isle	Indian Ocean	20	52 S	55	30 E
Brandenburgh	Prussia	54	37 N	20	17 E
Bridge Town	Barbadoes	13	5 N	59	41 W
Bridport	England	50	40 N	2	55 W
Brighthelmstone	England	50	50 N	0	5 W
Bristol	England	51	28 N	2	30 W

Names of Places.	*Sea or country.*	*Latitude.*		*Longitude.*	
Bruges	Flanders	51°	12′N	3°	12′E
Brunswick	Germany	52	14 N	10	41 E
Brussels	Brabant	50	21 N	4	21 E
Buda	Turkey	47	58 N	19	51 E
Buenos Ayres	Brazil	34	35 S	58	31W
Burhampoor	India	21	19 N	76	19 E
Bursa	Turkey	40	0 N	29	9 E
Buxar	India	25	24 N	83	58 E
Cabul	India	34	30 N	68	35 E
Cadiz	Spain	36	31 N	6	12W
Caen	France	49	11 N	0	22W
Caffa	Crimea	44	45 N	35	20 E
Cairo	Egypt	30	3 N	31	21 E
Calcutta	India	22	35 N	88	29 E
Calicut	India	11	18 N	75	52 E
Cambridge	England	52	13 N	0	4 E
Canary Isles (N. E. Pt.)	Atlantic Ocean	28	13 N	15	39W
Candy	Ceylon	7	22 N	80	48 E
Canterbury	England	51	18 N	1	5 E
Canton	China	23	8 N	113	2 E
Cape Clear	Ireland	51	18 N	11	15W
Cape Comorin	India	7	56 N	78	5 E
Cape Finisterre	Spain	42	52 N	9	17W
Cape Horn	South America	55	58 S	67	26W
Cape St. Vincent	Portugal	37	2 N	9	2W
Cape Verd	Africa	14	45 N	17	33W
Carthagena	America	10	26 N	75	27W
Casan	Siberia	55	44 N	49	8 E
Cashgar	Asia	43	0 N	71	15 E
Cashmere	India	34	20 N	73	42 E
Cayenne	America	4	56 N	52	15W
Celebes Isle (S. Pt.)	Indian Ocean	5	42 S	120	6 E
Ceylon (S. Pt.)	India	5	47 N	81	2 E
Chandernagore	India	22	49 N	88	28 E
Q. Charlotte (S.)	New Zealand	41	6 S	174	14 E
Charlestown	America	33	22 N	79	50W

Names of Places.	*Sea or Country.*	*Latitude.*		*Longitude.*	
Cherburg	France	49°	38′ N	1°	38′ W
Chidley	North America	60	22 N	63	0 W
Christmas Isle	Pacific Ocean	1	30 N	155	30 W
St. Christopher's Isle	Atlantic Ocean	17	15 N	62	43 W
Churchill Fort	America	59	0 N	94	0 W
Cochin	India	9	56 N	76	10 E
Coquet Island	England	55	20 N	1	30 W
Cork	Ireland	51	54 N	8	28 W
Cracow	Poland	49	59 N	19	50 E
Cusco	Peru	12	25 S	70	20 W
Cyprus (I.)	Asia	34	30 N	33	16 E
Damascus	Asia	33	0 N	36	41 E
Delhi	India	28	37 N	77	40 E
Diarbeker	Asia	37	28 N	40	0 E
Domingo (Cape Fr.)	America	19	46 N	72	18 W
Dover	England	51	8 N	1	18 E
Drake (Pt. Sir F.)	America	38	45 N	128	35 W
Dresden	Germany	51	6 N	13	31 E
Dublin	Ireland	53	20 N	6	6 W
Dunbar	Scotland	56	1 N	2	40 W
Dundee	Scotland	56	28 N	2	58 W
Durham	England	54	44 N	1	15 W
Easter Island	Pacific Ocean	27	6 S	109	47 W
Edinburgh	Scotland	55	58 N	3	12 W
Elbing	Poland	54	12 N	20	35 E
Ephesus	Asia	37	56 N	27	53 E
Erzerum	Asia	39	57 N	48	41 E
Falmouth	England	50	8 N	5	2 W
Faroe Islands	Northern Ocean	62	0 N	7	0 W
Cape Farewell	Greenland	59	38 N	42	42 W
Fayal Town	Azores	38	32 N	28	41 W
Ferro Island	Canaries	27	47 N	17	46 W
Florence	Italy	43	46 N	11	2 E
Florida Cape	America	25	47 N	80	35 W
Fowey	England	50	20 N	4	35 W
France, Isle of					

Names of Places	*Sea or Country.*	*Latitude.*	*Longitude.*
(S. W. Pt.)	Indian Ocean	20° 27′ N	57° 16′ E
Funchal	Madeira	32 38 N	17 6 W
Gallipagos Isles	Pacific Ocean	23 30 N	85 0 W
Gambia River	Africa	13 0 N	14 58 W
Ganjam	India	19 23 N	85 19 E
Geneva	Switzerland	46 12 N	6 0 E
Glasgow	Scotland	55 52 N	4 15 W
Goa	India	15 31 N	73 45 E
Gondar	Abyssinia	14 35 N	34 10 E
Good Hope (C.)	Africa	34 29 S	18 23 E
Goree Isle	Africa	14 40 N	17 25 W
Gottingen	Germany	51 32 N	9 53 E
Granville	France	48 50 N	1 37 W
Greenock	Scotland	55 57 N	4 43 W
GreenwichObs.	England	51 29 N	0 0
Guadaloupe	Atlantic Ocean	15 59 N	61 59 W
Guernsey	British Channel	49 30 N	2 52 W
Hague	Holland	52 4 N	4 17 E
Halifax	America	44 46 N	63 27 W
Hanover	Germany	52 22 N	9 48 E
Harwich	England	52 11 N	1 18 E
Havannah	Cuba	23 12 N	82 19 W
Heckla	Iceland	63 20 N	20 0 W
St. Helena	Atlantic Ocean	15 55 S	5 49 W
Hull	England	53 50 N	0 28 W
Jackson (Port)	New Holland	33 52 S	151 19 E
Jago (St.)	Cape Verd Isles	15 7 N	23 30 W
Jamaica (P. R.)	West Indies	18 0 N	76 44 W
Janeiro Rio	America	22 54 S	42 44 W
Jerusalem	Asia	31 47 N	35 20 E
Jesso (N. Pt.)	N. Pacific Ocean	45 0 N	145 0 E
St. John's	Newfoundland	47 32 N	52 26 W
Inverness	Scotland	57 36 N	4 15 W
Irkutsk	Siberia	54 30 N	104 30 E
Ispahan	Persia	32 25 N	52 50 E
Juan Fernandez	S. Pacific Ocean	33 45 S	78 37 W
Kamtschatka	Siberia	56 11 N	159 25 E
Kingston	Jamaica	17 57 N	76 33 W

Names of Places	*Sea or country.*	*Latitude.*		*Longitude.*	
Kiow	Russia	50	27 N	30	27 E
Ladrone Islands, Northernmost	Pacific Ocean	21	0 N	114	6 E
Lancaster	England	54	42 N	2	45W
Land's End	England	50	6 N	5	54W
Lassa	Asia	30	12 N	91	20 E
Leeds	England	53	48 N	1	34W
Leipsic	Germany	51	19 N	12	20 E
Leith	Scotland	56	0 N	3	11W
Lima	Peru	12	1 S	76	49W
Limerick	Ireland	52	22 N	9	53W
Liverpool	England	53	22 N	3	10W
Lizard	England	49	58 N	5	11W
London	England	51	31 N	0	6W
Louisburg	North America	45	33 N	59	55W
Lyons	France	45	46 N	4	49 E
Macao	China	22	12 N	113	46 E
Macassar	Celebes	5	9 S	119	49 E
Madeira	Atlantic Ocean	32	37 N	16	56W
Madras	India	32	5 N	80	29 E
Madrid	Spain	40	25 N	3	12W
Majorca	Mediterranean S.	39	35 N	2	30 E
Malacca	India	2	12 N	102	5 E
Malta	Mediterranean S.	35	54 N	14	28 E
Mangeen	S. Pacific Ocean	21	57 N	158	7W
Manilla	Philippines	14	36 N	120	35 E
Mantua	Italy	45	2 N	10	15 E
Marquesas (P. Madre de Dios)	Pacific Ocean	9	56 S	139	9W
Martinique (I.)	West Indies	14	35 N	61	9W
Masulipatam	India	16	9 N	81	10 E
Matapan (C)	Turkey	36	30 N	22	40 E
St. Matthew (I.)	Atlantic Ocean	1	30 S	7	20W
Mayo	Cape Verd Isles	15	10 N	23	5W
Mecca	Arabia	21	40 N	41	0 E
Medina	Arabia	24	58 N	39	53 E
Melun	France	48	34 N	4	5 E

Names of Places.	*Sea or Country.*	*Latitude.*			*Longitude.*	
Mexico	America	19	26′	N	100	6′W
St. Michael	Azores	37	47	N	25	42W
Milan	Italy	45	28	N	9	12 E
Minorca	Mediterranean S.	39	51	N	3	54 E
Mocha	Arabia	13	45	N	44	4 E
Montreal	Canada	45	50	N	73	11 W
Moscow	Russia	55	46	N	37	33 E
Namur	Netherlands	50	28	N	4	45 E
Nangasachi	Japan	32	32	N	128	46 E
Nankin	China	32	5	N	118	47 E
Navigator's Islands	S. Pacific Ocean	14	0	S	172	30 W
Naze	Norway	57	58	N	7	32 E
Negapatam	India	10	43	N	80	2 E
Nevers	France	46	59	N	3	9 E
Nevis(I.)	Atlantic Ocean	17	11	N	62	52 W
Newcastle	England	54	59	N	1	30 W
New Orleans	North America	29	58	N	89	59 W
Nootka	America	49	36	N	126	43 W
Nore	England	59	28	N	0	46 E
Norfolk Island	Pacific Ocean	29	2	N	168	10 E
North Cape	Europe	71	10	N	25	57 E
Nova Zembla	Arctic Ocean	78	0	N	70	0 E
Nuremberg	Germany	49	27	N	11	12 E
Oaitipeha Bay	Otaheite	17	26	S	149	36 W
Oczakow	Turkey	45	12	N	34	40 E
Okhotsk	Russia	59	30	N	145	0 E
Olmutz	Moravia	49	43	N	17	37 E
Oolashka(I.)	N. Pacific Ocean	53	55	N	166	30 W
Orleans	France	47	54	N	1	54 E
Ormus(I.)	Persia	27	30	N	55	17 E
Osnaburg(I.)	Pacific Ocean	17	52	S	148	6 W
Oxford	England	51		N	1	16 W
Owhyhee (N. Pt)	Pacific Ocean	20	17	N	155	58 W
Panama	America	8	48	N	80	21 W
Paramariboo	South America	6	0	N	55	30 W
Paris	France	48	50	N	2	20 E
Pegu	India	17	0	N	96	58 E

Names of Places.	*Sea or Country.*	*Latitude.*		*Longitude.*	
Pekin	China	39	54′N	116	27′E
Pelew Islands	Pacific Ocean	7	30 N	134	0 E
Philadelphia	America	39	57 N	75	13 W
Pico, Azores	Atlantic Ocean	38	29 N	28	26 W
Plymouth	England	50	21 N	4	7 W
Polostk	Russia	55	30 N	28	36 E
Pondicherry	India	11	42 N	79	52 E
Porto Rico (N. E. Pt.)	Atlantic Ocean	18	39 N	65	39 W
Portsmouth	England	50	48 N	1	6 W
Potosi	South America	19	0 S	67	30 W
Prague	Bohemia	50	5 N	14	24 E
Presburg	Hungary	48	8 N	17	33 E
Pylestaart	S. Pacific Ocean	22	23 S	175	41 W
Quebec	Canada	46	48 N	71	10 W
Quiloa	Africa	9	30 S	39	9 E
Quito	Peru	0	13 S	77	55 W
Rangoon	Asia	16	47 N	96	9 E
Rajepoor	India	17	19 N	73	50 E
Ratisbon	Germany	49	2 N	12	1 E
Rhode Island	America	41	28 N	71	30 W
Rhodes	Mediterranean	35	27 N	28	45 E
Rio Janeiro	Brazil	22	54 S	42	44 W
Rochester	England	51	26 N	0	30 E
Rome	Italy	41	54 N	21	29 E
Roque (C. St.)	Brazil	5	0 S	35	43 W
Rotterdam Isle	Pacific Ocean	20	16 S	174	30 W
Salisbury	England	51	4 N	1	47 W
Samarcand	Tartary	39	45 N	64	20 E
Samos	Archipelago	37	46 N	27	13 E
Sancto Cruz	Teneriffe	28	27 N	16	16 W
Sandwich Isles, Northernmost	Pacific Ocean	22	0 N	159	30 W
Saratov	Russia	51	30 N	46	0 E
Saragossa	Spain	41	40 N	0	39 W
Savannah	North America	32	3 N	81	24 W
Scandaroon	Syria	36	35 N	36	25 E
Senegal	Negroland	15	53 N	16	31 W

Names of Places.	*Sea or Country.*	*Latitude.*		*Longitude.*	
Senlis	France	49	12′N	2	35′E
Sennaar	Africa	15	0 N	29	30 E
Seringapatam	India	12	32 N	76	52 E
Severn House	North America	56	10 N	88	0 W
Seville	Spain	37	21 N	6	4 W
Shiraz	Persia	29	0 N	54	30 E
Siam	India	14	20 N	100	50 E
Sierra Leone	Africa	8	30 N	12	7 W
Smyrna	Asia	38	28 N	27	26 E
Society Isles (N. W.)	Pacific Ocean	17	30 N	152	0 W
Spitzbergen (N. Pt.)	Arctic Ocean	80	0 N	13	0 E
Stockholm	Sweden	59	20 N	18	4 E
Suez	Egypt	29	50 N	33	27 E
Sunderland	England	54	55 N	1	20 W
Surat	India	21	10 N	72	22 E
Surinam	South America	6	30 N	55	30 W
Tanjore	India	10	46 N	79	11 E
Tellicherry	India	11	42 N	75	30 E
Teneriffe	Canaries	28	17 N	16	29 W
Teignmouth	England	55	3 N	1	22 W
Tobago (N. E. Pt.)	Atlantic Ocean	11	29 N	59	57 W
Tobolski	Siberia	58	12 N	68	25 E
Tombuctoo	Africa	19	30 N	3	30 E
Tomsk	Siberia	56	30 N	84	59 E
Tongataboo (I.)	Pacific Ocean	21	9 S	174	46 W
Tonquin	India	20	50 N	105	55 E
Torbay	England	50	34 N	3	36 W
Tours	France	47	24 N	0	42 E
Toulouse	France	43	36 N	1	26 E
Trinidad	Atlantic Ocean	20	15 N	126	42 W
Tripoli	Bárbary	52	53 N	13	5 E
Tritchinopoly	India	10	49 N	78	46 E
Troyes	France	48	18 N	4	4 E
Truxilla	South America	8	0 S	78	35 W
Tunis	Africa	36	47 N	10	16 E
Turin	Italy	45	4 N	7	40 E

Names of Places.	*Sea or Country.*	*Latitude.*		*Longitude.*	
Tyre	Syria	33	10′N	35	24′E
Uliateah (I.)	Pacific Ocean	16	45 S	151	31W
Upsal	Sweden	59	52 N	17	39 E
Uraniberg	Denmark	55	55 N	12	45 E
Urbino	Italy	43	43 N	12	43 E
Utrecht	United Provinces	52	6 N	5	2 E
Valence	France	44	54 N	4	55 E
Vela Cape	America	12	15 N	71	20 W
Vellore	India	12	54 N	79	19 E
Vera Cruz	Mexico	19	9 N	96	0 W
Verona	Italy	45	26 N	11	1[illegible] E
Versailles	France	48	48 N	2	[illegible] E
Vienna	Germany	48	13 N	16	23 E
Warsaw	Poland	52	14 N	21	[illegible]0 E
Washington	North America	39	0 N	77	10W
Wells	England	53	7 N	1	0 W
Weymouth	England	52	40 N	2	34W
Whale Isle (W. Pt.)	North America	69	14 N	135	0W
Whitby	England	54	29 N	0	50W
William (Fort)	Bengal	[See Calcutta]			
Wrath (C.)	Scotland	58	40 N	4	50 E
Yarmouth	England	52	55 N	1	40 E
Yellow River	China	34	6 N	120	10 E
York	England	53	59 N	1	7 W
York (New)	North America	40	40 N	74	11 W
Zurich	Swisserland	47	22 N	9	21 E

A TABLE,

Containing the length of a degree of longitude in English miles for every degree of latitude.

Lat.	*Deg. of Long.*	*Lat.*	*Deg. of Long.*	*Lat.*	*Deg. of Long.*	*Lat.*	*Deg. of Long.*
0°	69.2000	23°	63.6986	46°	48.0705	68°	25.9230
1	69.1896	24	63.2177	47	47.1944	69	24.7992
2	69.1578	25	62.7167	48	46.3038	70	23.6678
3	69.1052	26	62.1963	49	45.3994	71	22.5294
4	69.0312	27	61.6579	50	44.4811	72	21.3842
5	68.9363	28	61.1001	51	43.5489	73	20.2320
6	68.8208	29	60.5237	52	42.6037	74	19.0743
7	68.6845	30	59.9293	53	41.6453	75	17.9103
8	68.5267	31	59.3162	54	40.6751	76	16.7409
9	68.3481	32	58.6851	55	39.6917	77	15.5665
10	68.1489	33	58.0360	56	38.6959	78	14.3874
11	67.9288	34	57.3696	57	37.6891	79	13.2041
12	67.6880	35	56.6852	58	36.6705	80	12.0166
13	67.4264	36	55.9842	59	35.6408	81	10.8250
14	67.1448	37	55.2659	60	34.6000	82	9.6306
15	66.8424	38	54.5303	61	33.5489	83	8.4334
16	66.5192	39	53.7788	62	32.4873	84	7.2335
17	66.1760	40	53.0100	63	31.4161	85	6.0315
18	65.8134	41	52.2259	64	30.3352	86	4.8274
19	65.4300	42	51.4253	65	29.2453	87	3.6219
20	65.0265	43	50.6094	66	28.1464	88	2.4151
21	64.6037	44	49.7783	67	27.0385	89	1.2075
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RENTING 'EM OUT.

It's a cold day when California doesn't spring a new sensation.

Apparently she has built herself that way, especially in a social sense.

She may be through with earthquakes, as she streunously claims; but she can't successfully deny that she's through with social upheavals.

When her film actors aren't creating sensations, the rest of her citizens are heedless of everyday amenities and the eternal fitness of things.

And now comes a woman out there who has divorced one husband, applied for divorce from a second husband, and desires to rent another woman's husband—at the rate of one hundred dollars a month.

The woman who has legal claim to the attractive husband doesn't want to rent him out; she wants to sell him—for $25,000 cash in hand.

What a mad and merry state of affairs! If this renting of husbands is to become fashionable and prevalent, we must have laws, rules and regulations governing such business activities.

Perhaps the rate of rentals should be established in the courts.

The true value of each husband should be determined, maybe, and a fair profit on the investment provided.

Doubtless, a wife should clear six per cent on the value of her husband, when she rents him.

A husband worth $25,000 would then bring in $1,500 yearly.

Not an unprofitable business—$125 a month.

Enterprising females might own and manage whole herds of lovely husbands. Why not?

And, of course, there would be many women who would consider it more satisfactory and economical to rent husbands than to own them exclusively.

Owners would carry insurance on their husbands, of course.

And they would have to bind themselves to keep 'em in fair condition.

All repairs would have to be made by the owners; but the renters would have to be bound to be careful of the rented property.

Steady use would be allowed, to be sure; but no abuse would be permitted.

Needless damages would have to be paid for by the renters.

We're moving rapidly these days, and California's in the van.

Yes, we're on the way; but whither are we bound?

Many persons don't care, seemingly.

With them it's just step [illegible] and let [illegible] the end of the [illegible] all day [illegible]

SUIT

All the smartnes
wants in suits
fabrics carefully
finished, some
foreign - this is
are such fine va

CARSON P
AND C